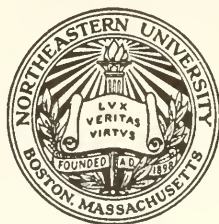


HISTORY
OF THE
PORTLAND CEMENT INDUSTRY
IN THE UNITED STATES



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To my dear old friend
Clemens Herschell with
complements & best wishes
of ————— Berkeley

March 24/25

HISTORY
OF THE
PORTLAND CEMENT INDUSTRY
IN THE UNITED STATES

HISTORY

OF THE

PORTLAND CEMENT INDUSTRY IN THE UNITED STATES

WITH

Appendices Covering Progress of the Industry by Years

AND

An Outline of the Organization and
Activities of the Portland Cement Association

Written by

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DEDICATED
TO THE USERS OF
CONCRETE

*That plastic stone shapen by human
artificers which transcends in utility
the product of Nature's workshop*

344310

FOREWORD

By FLOYD W. PARSONS*

What you are, speaks so loudly that people oftentimes do not hear what you say. The Cement Industry of the United States has established for itself a position of such permanence and importance in America's industrial life, that neither arguments nor eulogies are needed to gain public recognition and appreciation for this great business. We may search the whole field of material virtues and yet find nothing that so commands our respect as does permanence. It is not the beauty of the Pyramids that holds the traveler in Egypt charmed, but it is the appeal their rugged endurance makes to his imagination. They appear to be something that connects today with yesterday—the present with the past—and while they may represent no more than a foolish waste of human effort, they have the power to go on and on, unyielding even to the ceaseless attacks of the wearing elements and the sands of the desert.

Cement means concrete; concrete means stone; and stone spells eternity, so far as our finite minds can comprehend. The development of methods to manufacture great quantities of synthetic stone has given our present civilization the durability it so much needed. The creation of a great Cement Industry has removed, in large degree, the serious menace to life of a coming timber famine. The rapid progress of science and engineering in our country has been made possible by our cement mills, which have given us the essential material on which to found our prosperity.

The greatest romance that was ever known is the story of Industrial America. It seems only yesterday since the average family was an independent unit, the head of the house being the family shoemaker and tailor as well as breadwinner. Now we are a nation on wheels; life is automatic, and monsters made of iron have lifted the load of labor from human shoulders. We are going forward so fast that we have found it difficult to keep our rearward lines of communication fully open. If the total age of mankind be expressed as 50 years, we find that the human race did not even know how to scratch the simplest records on stone until its 49th year. On such a basis, printing has only been in use three months. The benefits of steam were realized only four days ago. Electricity, street cars and telephones arrived only day before yesterday. And the automobile, X-ray, radium and wireless were discovered on our fiftieth birthday. There is

*EDITOR'S NOTE: Floyd W. Parsons is a member of the American Institute of Mining and Metallurgical Engineers; Academy of Political Science; Founder and Former Editor of *Coal Age*; Author of "Everybody's Business" in *The Saturday Evening Post*; Editorial Director of *Gas Age-Record*; Contributing Editor of *Advertising Fortnightly*; Regular Writer in *The World's Work*; and Author of "American Business Methods."

FOREWORD

more chemistry now in the atom alone than there was in the entire field of inorganic chemistry a few years ago.

But although we have been going ahead at a furious pace, the speed of our advance has been nothing compared with what it will be in the years that lie just ahead. It is not only the United States that has found itself, but the whole world is awakening. Radio has eliminated distance in the matter of conversation and will rapidly remove the barriers to one universal language throughout the world. Aerial navigation is making it possible to measure distance by minutes instead of miles. Soon great ships will travel all the lanes of the air by routes as straight as the crow flies, to every part of the globe.

Many people who read this were born before the invention of the electric light, the dynamo, the telephone and the phonograph. Hundreds of other discoveries of even greater consequence will be witnessed by many of us before we pass on. The real creative power of the human mind is only now being let loose. One marvel will be piled on another. Things in common use today will be obsolete tomorrow. New industries of great importance and magnitude will be created literally over night. And in all of this amazing drama the United States is destined to play the principal role.

There never was a time when it was so necessary as now for leaders of industry to correctly visualize the future. Earnest research workers toiling in laboratories are going to give us hundreds of substitutes for many of the things we now use. This means that a great number of our industries are building their futures on the shifting sands of uncertainty. But there are other important businesses in our industrial system that are just as permanent as they are basic. Chief among these fortunate lines of activity is the manufacture of cement. Timber and cement bear the same relation to each other in the field of construction that petroleum and coal bear to each other in the field of fuel. The lumber business is a great industry, but we are fast coming to a time when we must grow our timber very much as we now grow corn and wheat, the only difference being that we will harvest our timber crop once every 50 or 75 years instead of annually. So it will be with petroleum. When our ground oil gives out, we will have to manufacture our motor fuels and lubricants from such things as shale rock and vegetable matter.

But our supplies of coal, and the materials that go into the manufacture of cement, are present in most of our states in quantities adequate to satisfy the needs of centuries. The processes of manufacturing cement may change. Gas may be substituted for coal as a fuel. Refinements of many kinds and in many places may be introduced into the scheme of

FOREWORD

operations. But the basic materials will be the same, and thereby rests the security of the industry's future.

The leaders of a great business like cement manufacture are today shouldered with a great responsibility. Some things we can do without, but we might as well attempt to hide the sun with a sieve as to try to create a high degree of prosperity in our land without an adequate supply of cement. If destiny has decreed that we must do the world's manufacturing, this means we must have more and better highways, more dams, more sidewalks and curbings, more subways and tunnels, more bridges, more barns and other farm structures, more machine foundations, more coal bins, and more homes, offices and factories that will stand unimpaired in the face of driving flames and the destructive action of natural elements. Where one thing is made of cement today, we will make 100 tomorrow.

We call attention to the fact that cement manufacture is an infant industry; that production has jumped from less than 10,000,000 barrels a year, to nearly 150,000,000 barrels in a quarter of a century; that the business has been developed in a comparatively short time, from a more or less disorganized national enterprise, into a modern industrial undertaking that even in progressive America is regarded as a model in the field of sound, scientific research, effective educational work and vigorous salesmanship, but all that has been accomplished is but a mere preliminary to the great work that is coming.

This industry has been fortunate in the character of its leaders. Saylor, Miller, Shinn, Lesley, de Navarro, Lober, Bartlett, and the other pioneers, not only had faith and courage, but they had vision and imagination, without which industry lags and the future is hopeless. In the light of individual effort the Cement Industry may well congratulate itself upon its past achievements. But success is always accompanied by responsibility. Yesterday's records represent only accomplishments that must be surpassed. It is harder to keep a good reputation than to acquire a bad one. It is easier to step into another man's shoes than it is to walk in them. The younger men coming into leadership in our country's great cement industry are set the task of so performing that, when the next mile-stone of progress is reached, there will be as little occasion for regrets as there is today.

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The Edystone Lighthouse, built in 1756 by John Smeaton, a noted British engineer. Repeated failures of this structure, due to lack of an efficient binding material for the stone masonry, paved the way for the invention of portland cement.

HISTORY OF THE PORTLAND CEMENT INDUSTRY IN THE UNITED STATES

CHAPTER I

CEMENTS AND THEIR DEFINITION

Cementing Materials Known Since the Dawn of History

History records that the early Romans and Egyptians were familiar with a variety of mortars and mortar making materials. Remains of structures of those days show the use of mortar binders in what we would call masonry construction, and also a very extensive use of some kind of mortar in the form of stuccoes. That these early workers possessed no mean knowledge of mortars is perhaps best evidenced by the remarkable state of preservation even at this day of the many early examples of stucco.

General Classes in which Cementing Materials Fall

Mortar binders may conveniently be considered in two broad classes—limes and cements. Falling between these classes are hydraulic limes, so largely used in western and central Europe. Cements, likewise, may be divided into two general classes—natural and portland cements. In addition to these are the variations known as puzzuolana, slag cement and iron cement, the last mentioned being best known in Germany.

Essential Difference Between Natural and Portland Cement

The main difference between natural and portland cement is that the former is a direct product of rocks as found in nature, burned usually in open kilns, while portland cement is a scientifically controlled product, made from properly proportioned calcareous and argillaceous materials. When these materials are burned in kilns and artificially proportioned, a chemically combined material called clinker is the result. Natural cement is burned at a lower temperature than required to produce portland cement clinker; but in both cases, after burning, the materials are ground into a fine powder, which is the cement of commerce.

More extended definitions of some cements follow:

PUZZUOLANA is a cement of volcanic origin. Its name is derived from Puzzuoli, an Italian city near the base of Mount Vesuvius, where the properties of puzzuolana were first discovered. The Romans used this cement extensively in their hydraulic works. The material was pulverized and mixed with slaked lime and a small amount of sand to form hydraulic mortar. Puzzuolana is a silicate of alumina in which the silica exists in a state easily attacked by caustic alkalies. Hence it readily combines with lime in the mortar.

Trass, a volcanic material found in Germany and Holland, and arenas, a sand found in France, were used in the same manner.

Puzzuolana may be produced artificially by burning certain kinds of clay. The natural material may frequently be improved by burning. In America, a cement called puzzolan has been manufactured for many years from lime and blast furnace slag. It is described later under "Slag Cement."

NATURAL CEMENT, as the name implies, is essentially formed by nature. Certain argillaceous limestones containing various percentages of lime, silica and alumina are quarried and burned in their natural state in open lime kilns at comparatively low temperatures. The resultant product when reduced to a fine powder is the natural cement of commerce.

The American Society for Testing Materials defines natural cement as follows:

Natural cement is the finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the carbonic acid gas.

To better illustrate what is meant by natural cement, a cement rock of the Lehigh district in Pennsylvania may be used as an example. This rock is of a laminated nature and even to the unaided eye, and much more so under the microscope, shows various layers or leaves of varying material. For practical purposes, it may happen that one of these small layers is lime, another alumina and another silica; or there may be a large layer of lime, two layers of silica together and a small layer of alumina. This rock when calcined, either under high or low temperature, will not combine in all its elements or parts. Consequently, for purposes of comparison between natural and portland cement, it may be broadly stated that from 20 to 25 per cent of the natural cement is inert or not in combination. By taking the portions of silica and alumina that should combine properly with the lime, it will be found there are certain proportions in excess and therefore uncombined. These natural cement rocks are burned at a comparatively low heat with coal, and the resulting material when drawn from the kiln is not very hard and can be reduced to fine powder with comparative ease.

Among the natural cements may be included the well known ones of the Rosendale, (New York), Potomac, (Maryland), Lehigh, (Pennsyl-

vania), Akron, (New York), Louisville, (Kentucky) and Utica, (Illinois) districts. All of these cements have enjoyed a proper reputation and have been used in important work throughout the United States.

PORTLAND CEMENT is so named because the early product, when set, is said to have resembled in color a famous building stone on the Isle of Portland, England.

Portland cement is the product obtained by finely pulverizing clinker



This mill at Williamsville, New York, built in 1824, supplied natural cement for the construction of the original locks on the Erie Canal at Lockport, New York.

resulting from the burning to incipient fusion of an intimate artificial mixture of finely ground calcareous and argillaceous materials.

The official definition of the American Society for Testing Materials is as follows:

Portland cement is the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no addition subsequent to calcination except water and calcined or uncalcined gypsum.

Essential Composition of Portland Cement

In general, the composition of portland cement is about 20 per cent silica, 10 per cent alumina, plus ferric oxide, 65 per cent of lime and 5 per

cent of other compounds. The required combination of the foregoing materials may be obtained by mixing limestone, chalks or marl with clay or shale or other argillaceous materials, or by taking a cement rock in which all ingredients are present in nearly the proper proportions, then adding limestone or argillaceous material as may be required to produce the proper balance of these ingredients. It is also made by adding limestone to blast furnace slag of low magnesia content. During burning, the combination of the lime and silica, alumina and iron oxide takes place. The product resulting from proper burning is called clinker. This consists of silicates, aluminates and ferrites of lime in certain definite proportions. The portland cement of commerce is the product resulting from grinding this clinker to a fine powder.

The fact that there is considerable variety of raw materials entering into portland cement manufacture has resulted in a classification of materials. Richard K. Meade, in his well known book "Portland Cement," places materials under two general heads according to how the lime or silica and alumina predominate.

The following are his distinctions:

Calcareous	Argillaceous
Limestone	Clay
Marl	Shale
Chalk	Slate
Alkali Waste	Blast Furnace Slag
	Cement Rock

In this classification the author states that cement rock may be considered as either calcareous or argillaceous, but usually argillaceous. But in one section of the Lehigh region the lime content is so high as to require an admixture of slate or clay.

Concerning distribution of materials, cement rock and limestone are found in the Lehigh district of Pennsylvania. In the early days of portland cement manufacture in this country, Michigan, Ohio, Indiana and central New York plants used marl and clay or shale. In more recent use, however, limestone has in many cases been substituted for marl. Throughout the country generally there are many deposits of limestone and shale or clay. In Indiana, Minnesota, Ohio and Pennsylvania a true portland cement is manufactured from blast furnace slag and limestone.

SLAG CEMENT, otherwise known as "puzzolan" cement is produced by the intimate mechanical mixture of slaked lime and granulated blast furnace slag. Both materials are pulverized before, during, or after mixing. Slag cement is not subjected to fire in kilns during the process of manufacture. It is inferior to portland cement in strength and other qualities. It found little market either in this country or abroad.

"**EISEN**" **PORTLAND, OR IRON CEMENT** is made in Germany, where it enjoys a large demand. It is prepared by adding to true

portland cement clinker, selected blast furnace slag in proportions varying from 15 to 25 per cent, then grinding the resulting mixture to the fineness required by the German Government specifications for portland cement.

SILICA SAND CEMENT is another type of mixed cement, where high grade silica sand or crushed granite is added to portland cement clinker in quantities varying from 20 to 30 per cent, and the resulting mixture reduced to an impalpable powder.

BLENDED CEMENT is a name that was given to cement which partook of the natures of puzzolan and portland cement. It was produced in California in connection with the construction of the Los Angeles Aqueduct, being made by regrinding portland cement with volcanic tuff. It was known locally as "tufa" cement.

COLLOS CEMENT began to attract attention about 1910. It was a patented product produced by slowly pouring molten blast furnace slag, when suitable for the purpose, or by pouring the molten material when fused directly for the purpose in a blast furnace, upon a rapidly revolving corrugated cylinder, which scattered it in finely distributed particles. While still in molten state, the particles came in contact with a spray of a relatively small amount of weak solution of one or more of the soluble salts of alkaline earths, magnesium sulphate being generally used. The particles were then collected, cooled and ground to a fine powder. The resulting product differed materially from both portland and puzzolan cements.

PASSOW CEMENT is a slag cement manufactured under patents granted to Dr. Passow, one of the leading scientists of Germany, after whom it was named. Its production in America is described elsewhere.

Note: The reader who is interested in pursuing a more detailed technical discussion of some of the cements mentioned in the foregoing, as well as cement manufacture in its broader aspect, will find much of interest in the following books:

"Calcareous Cements," by Redgrave and Spackman, published by Charles Griffin & Co., 1905. This book gives an unusually complete account of the early history of cements and also a very satisfactory treatment of numerous types of cement other than portland.

"Portland Cement," by R. K. Meade, Chemical Publishing Co., Easton, Pa., 1911. Based largely on American practice; probably the best general treatment which has been published in this country.

"Cement," by Bertram Blount, published by Longmans, Green & Co., London, 1920. Reflects modern English practice and theories.

"Portland Cement," by Arthur C. Davis, published by John Falconer, Dublin, 1922. This book deals with English practice in the manufacture of portland cement.

"Cements, Limes and Plasters," by Edwin C. Eckel, published by John Wiley & Sons, New York, 1922. This publication deals with raw materials, their manufacture and properties.

Note: For information concerning the more technical features of portland cement, see also papers on this subject published by Geophysical Laboratory, Washington, U. S. Bureau of Standards, Association of German Portland Cement Manufacturers and periodical literature.

Bibliography on Lime, Cement and Concrete

The following list of old, rare and out-of-print books on lime, cement and concrete, has been compiled by the Structural Materials Research Laboratory, Lewis Institute, Chicago, and are now in the library of the Structural Materials Research Laboratory.

It is probable that the more important libraries in various large cities throughout the country contain some, if not all, of these publications:

Date of Original
Publication

- 50 (?) B.C. "Architecture," by P. Vitruvius; translated from Latin by Joseph Gwilt (John Weale, London, 1860).
- 50 (?) B.C. "The Ten Books on Architecture," by Vitruvius; translated by Morris H. Morgan (Harvard University Press, Cambridge, 1914).
- 1774 "Practical Essay on a Cement and Artificial Stone," by M. Lorient; translated from French (T. Cadell, London).
- 1776 "Treatise on Building in Water," by G. Semple (J. A. Husband, Dublin).
- 1780 "Essays on Cements," by Bry Higgins; bound with essay of M. Lorient, (T. Cadell, London).
- 1791 "Narrative of the Building of the Edystone Lighthouse," by John Smeaton; 2d Edition, London, 1813. Book IV gives an account of experiments, manufacture, and use of "water cements." (Longman, Hurst, Rees, Orme and Brown.)
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- Iowa State College Engineering Experiment Station
 - Bulletins relating to cement, concrete, and brick (1903-date)
- University of Missouri Engineering Experiment Station
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 - Transactions, v.1-18 (1899-1917)
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Inventive Minds of All Ages Interested in Cementing Materials

The subject of cementing materials seems to have attracted the attention of studious and inventive minds in all ages. Vitruvius, who in the early days of Rome, wrote much about mortars, had a great deal to say about lime and its uses, but it was ages afterward when a French inventor



Ruins of one of the earliest cement kilns built in this country, that of the Thomas Millen plant at South Bend, Indiana.

petitioned his king to grant a patent for the use of quicklime in mortar as distinguished from the old method whereby lime and sand were slaked together and permitted to remain in pits for many months before use.

Early Writings of Vicat

L. J. Vicat, a distinguished French engineer and author of numerous technical works, was practically the first within comparatively modern times to go into the complexities and variations in lime and its uses. In 1818, he published a book which was translated by Captain J. T. Smith

under the title "A Practical and Scientific Treatise on Calcareous Mortars and Cements, Artificial and Natural," and published in London in 1837. It has ever since been regarded as a classic on the subject. Vicat's remarkable book shows how extended and thorough had been his research, and due to his investigations, especially of hydraulic limes, much of that known about cement today had its origin in this early work. Though published more than a century ago, the book seems quite modern. Vicat classified calcareous materials and defined the various kinds of lime they furnished. His study of clays was equally comprehensive. He described the qualities of different materials used with lime in the manufacture of mortars or calcareous cements. His research included observation as to the action of various substances upon mortars, and comparisons between mortars of ancient and modern times. In a chapter on natural cement, he made the following prophecy:

That which is in England very improperly termed Roman cement is nothing more than a natural cement resulting from a slight calcination of a calcareous mineral, containing about 31 per cent of ochreous clay and a few hundredths of carbonate of magnesia and manganese. A very great consumption of this cement takes place in London, but its use will infallibly become restricted in proportion as the mortars of eminently hydraulic lime shall become better known and in consequence better appreciated.

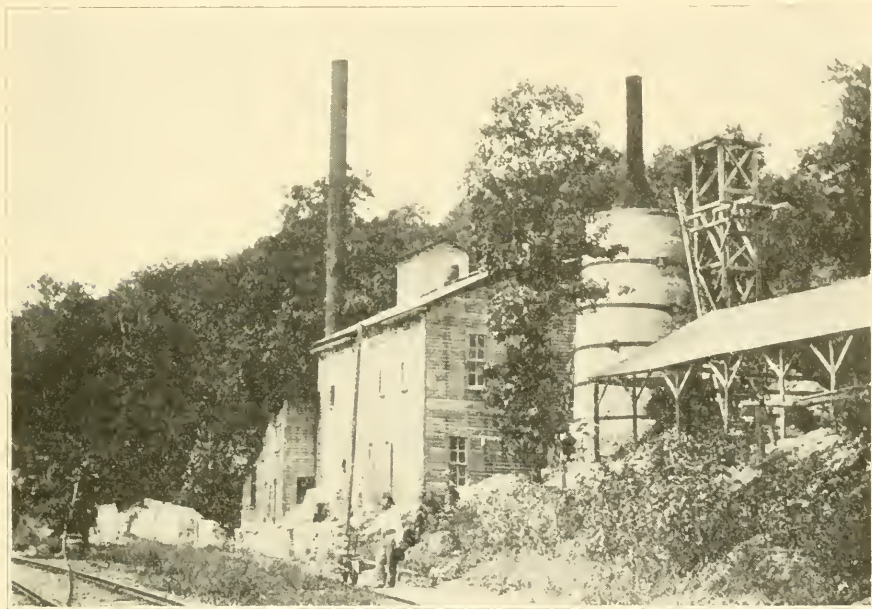
Vicat had followed up the discovery of John Smeaton, of Edystone fame, as to the advantage of clay in natural limestone to make such limestone hydraulic. This was accomplished by mixing rich lime with varying percentages of clay, to which Vicat refers in his book when he says: "We have no longer, therefore, to attend to laboratory experiments, but indeed, to a new art very nearly arrived at perfection." This new art, described in 1818, was what has now become the art of making portland cement, although Vicat did not describe it by that name, nor did he in his early experiments arrive at the results which he subsequently obtained.

Dr. Bry Higgins Among Early Investigators and Writers

Perhaps few, if any, writers among those who recorded their studies of cements and mortars, surpassed Dr. Bry Higgins. In 1780, he published a book under the title "Experiments and Observations Made with a View of Improving the Art of Composing and Applying Calcareous Cements, etc." Dr. Higgins regarded the subject of greatest importance, since he realized that "the strength and duration of our most useful and expensive buildings depend chiefly on the goodness of the cement with which they are constructed." He referred to his coworkers in this field as artists and gave much credit to a certain Dr. Black, who also appears to have been a student in this field of research.

Dr. Higgins found human nature in his day not much different from that of today. On the subject of fire resistive building construction, he says:

The public are indebted to Mr. Hartley for the experimental proofs he has given to the efficacy of his method of securing houses from fire; and to Lord Mahon for those judicious and expensive experiments by which he has shewn that a calcareous incrustation answers the purpose of Mr. Hartley's art. I am afraid that their good intentions will be frustrated by the indifference of men to distant or improbable evils, and their dislike to any immediate expense which affords no extemporary convenience or ornament.



Said to be the first cement mill in Illinois, located at Deer Park near LaSalle. The modern successors to this humble beginning in cement manufacture are not far from this spot.

CHAPTER II

AMONG THE PIONEERS IN NATURAL CEMENT

Edystone Lighthouse Impelled Research for Better Hydraulic Mortar

In 1756, John Smeaton, who in 1791 described his experiments when writing of the construction of the Edystone Lighthouse, developed the thought which led to the discovery of the ingredients of hydraulic mortar. He laid down the principle that the hydraulic properties of a limestone depend not, as had been formerly supposed, upon color or texture, but upon the percentage of clay entering into its chemical composition. Announcement of this discovery naturally directed examination on the part of engineers and others, of various limestones and other materials found throughout England.

Almost contemporaneous with Smeaton's publication was the patent granted Joseph Parker, who claimed to make Parker's Cement out of certain stones or argillaceous products. This patent he followed up in 1796 by a second one for the use of nodules, or "noddles," of clay which he found along the Kentish coast of England. Later on the name of Roman Cement was given to this product, which commanded quite a large sale in England.

Almost simultaneous with the work of Parker, but still following Smeaton's discovery, one Lesage, connected with the French army, found similar nodules at Boulogne, from which he made good quick setting cement along in 1796. Chemically speaking, all of these were natural cements and analyzed very nearly alike—about 45 per cent of lime to 30 per cent of silica and alumina.

Established Reputation of Natural Cement Impeded Progress of Portland Cement

As a sidelight of cement history, it may be mentioned briefly here that in the face of the greater cost of producing portland cement, the reputation of the English natural cements was so great that for several years following the establishment of portland cement works, the natural product commanded a higher price; and for quite a time it seemed as though the manufacture of natural cement would endure to such an extent as to block the development of the then new portland cement industry.

Transportation Developments Forced Attention to Cement

The early history of the United States shows that necessity was frequently the mother of invention. Where construction grew on the basis of the people's needs and the materials came from what was ready at hand, it was most natural that we should have wooden buildings, pavements, sewer boxes, plank roads and, in general, a widespread use of lumber because of its ready availability. The progressive development of our resources naturally made better methods of transportation essential. The development of the country beyond the Alleghenies, the growth of the western part of New York State, the establishment of communities along the Great Lakes, made better means of transport essential between the seacoast and inland communities.

During this period, say from 1800 to 1820, methods of transportation were both primitive and limited. The practicability of steamship navigation had been demonstrated, but had not become available. Railroad building did not start until 1837. Horse-drawn wagons over the roughest of roads were practically the only means of intercommunication.

Canal Development Required Watertight Masonry

Canals had become an old institution in Europe and with the impelling force of necessity, engineering and financial minds in the United States turned to canals as the solution of the then pressing transportation needs of this country. Canals necessarily involve problems dealing with water and masonry. There must be locks, bridges over small streams, aqueducts to carry the canal over valleys, and all of these involve water-resisting mortar. From these needs resulted the early discovery of natural cement in the United States.

Erie Canal Responsible for Discovery of Natural Cement Rock in United States

The building of the Erie Canal, which was started in 1817, was not only the greatest of early transportation projects in this country in which cement played a most important part, but led to the discovery of natural cement rock in the United States. According to the best authorities available, this discovery was made in 1818 by Canvas White near Fayetteville, Onondaga County, New York. Mr. White took out a patent which was later sold by him to the State of New York for \$10,000. State control of this patent finally resulted in removal of all manufacturing restrictions under the White process.

Richard K. Meade, in his book already referred to, quotes a county history which states that Mr. White made his discovery near Chittenango,

Madison County, New York, and that after experimenting with the rock, applied to the state for the exclusive right to manufacture for twenty years. This right the state declined to grant, but gave Mr. White \$20,000 in recognition of his valuable discovery. Thus do "authorities" cloud the facts. For the cement used in such large quantities on the canal, White received about 20 cents a bushel.

Under the administration of DeWitt Clinton as Governor of New York, work on the Erie Canal proceeded rapidly from the Hudson River to Lake Erie. Other sections of the United States were clamoring for canals. The Richmond and Allegheny Canal, extending from the James River to the Allegheny Mountains; the Chesapeake and Ohio Canal, from Baltimore to the headwaters of the Potomac; the Lehigh and the Pennsylvania State Canals in Pennsylvania; the Great Canal around the Falls of the Ohio at Louisville, Kentucky, and canals started in the vicinity of Chicago, all were dependent upon hydraulic cement, as each required water-resisting mortar for safety and permanence. It is evident that the development of the canal system of the United States in the early days therefore went hand in hand with the development of the American Natural Cement Industry.

It is a matter of history that the Rosendale, Akron and Howes Cave cement districts in New York; the Lehigh Valley cement district in Pennsylvania; the Cumberland, Round Top and Shepherdstown districts in Maryland and West Virginia; the Balcony Falls district in Virginia; the Louisville cement district near Louisville, Kentucky; the Milwaukee district in Wisconsin, and the Utica district in Illinois, were practically all discovered and brought into being through the need of cement mortar for the construction of our artificial inland waterways. Also, as in Europe, where, in the early days of cement manufacture, canals and waterways were the thoroughfares of transportation to market, so in this country similar methods were part of the history of the development of the cement industry. Out of this fact grew the employment of the wooden barrel, tight against moisture, as a shipping container. It was more than half a century after the discovery of natural cement in this country and the advent of railroads as a superior means of transportation, that it was discovered that the cotton sack and paper bag were equally good shipping containers.

The pioneers who had the courage to build these early cement mills and produce a new article of commerce were men of keen foresight and strong business purposes. In the group that developed the Rosendale district on the Hudson near Rondout, New York, were men of the highest type in business ability and integrity.

Personalities in the Early History of Natural Cement Manufacture

Among the earlier companies was the Lawrence Cement Company, which manufactured the Hoffman Brand. Its officers included Watson H.

Lawrence, Warren Ackerman, Dr. Woodward and M. Albert Scull. This company was one of the large producers in its day. The order and old-time business methods that pervaded its offices and the fair dealing which stamped every one of its transactions were proverbial among those who dealt with Rosendale cement in the early days.

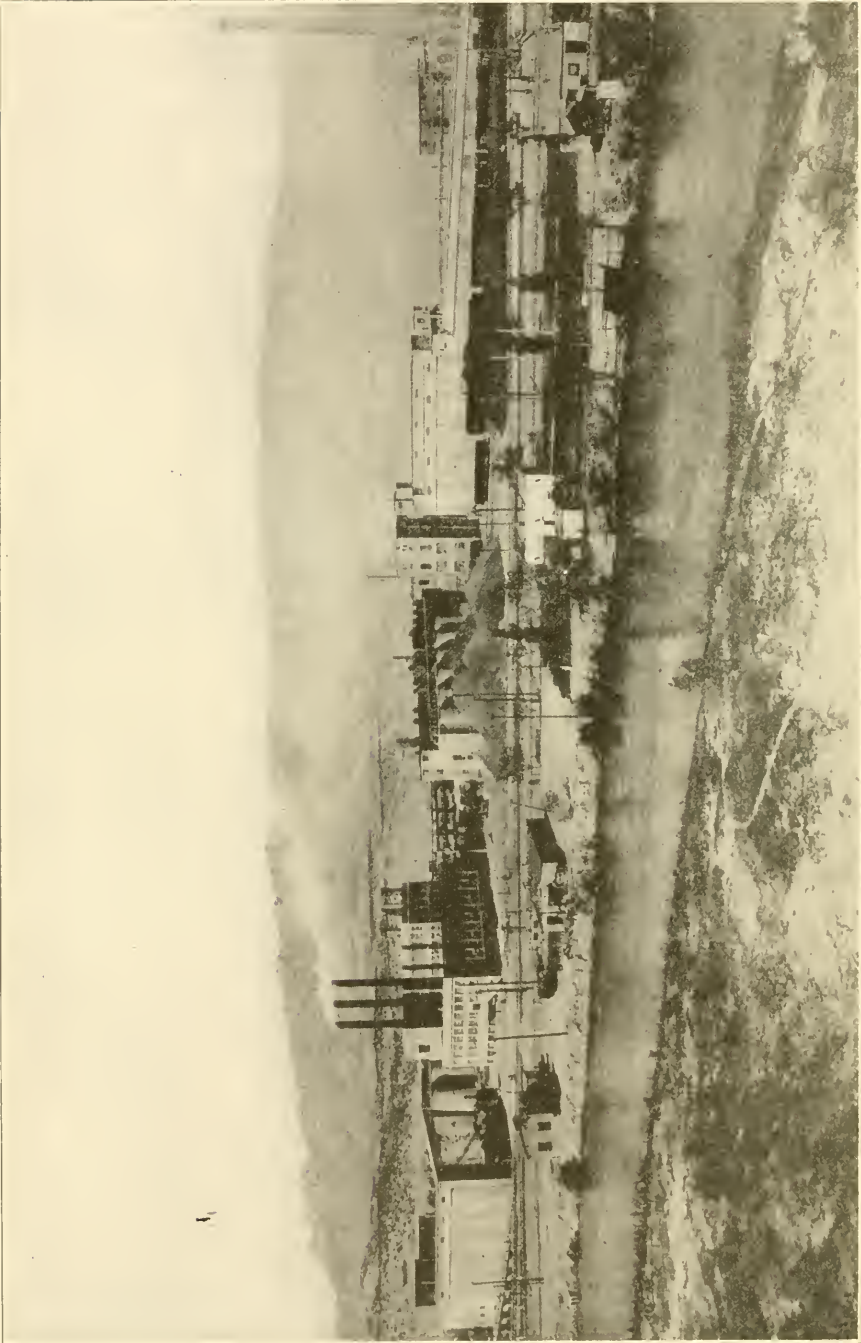
Harry Brigham and S. D. Coykendall were two well known pioneer manufacturers identified with a group of mills known as the Hudson River Company near Rondout. Mr. Brigham was known as a distributor; Coykendall as an owner of barge and steamship lines and a pioneer in railroading in the Catskills. Coykendall started the manufacture of portland cement in the early days of the cement industry in this country but gave it up, holding until the day of his death a belief in a permanent market for Rosendale natural cement.

✧ The Newark and Rosendale Company was another large concern in Newark, owned principally by the Tompkins family and associates. One of the younger Tompkins was Dock Commissioner in New York and for many years held high positions in business circles.

Another of the bright lights in the Rosendale field was Wm. N. Beach, a handsome, gray mustached, physically fit type of New York business man, keen, alert, wise in the handling of his mills and plants and a man who made many friends.

Among those in the strictly scientific or engineering side of cement manufacture in the early days was F. O. Norton, manufacturer of the Norton Brand. Mr. Norton was a member of the American Society of Civil Engineers and prominently associated with the foremost bridge, canal and railroad builders of his time. Perhaps more credit is due to him than any of the other early group for putting Rosendale cement, especially the Norton brand, in the front ranks of favor by the engineering profession. It is related of Mr. Norton that when the Lehigh cements first began to make their way into the New York market and endeavor to have a specification made by the engineering societies for all natural cements, he was against any specification on the ground that his cement was the best. "But," said the Lehigh manufacturers, "if we don't get a specification, how can we get into the market?" "Well," said Mr. Norton, "when I have sold all the cement my mill can make, you may have your chance to sell yours."

✧ The Howes Cave Association, organized in 1869 and subsequently consolidated with the Howes Cave Lime & Cement Company, was among the early manufacturers of natural cement. These merged concerns finally became the present Helderberg Cement Company. The Howes Cave Lime & Cement Company made natural or Rosendale brands, known as "Ramsey's Cement," "Rose's Cement," and "Howes Cave Cement." The manufacture of natural cement continued after the Helder-



This view of a present-day cement plant indicates that even moderate-sized plants, as plants go today, conduct manufacturing operations on a large scale.

berg Company was incorporated, or until 1905. Maximum production reached about 10,000 barrels per month.

F. W. Kelley, at this writing President of the Helderberg Company, has supplied the following facts concerning the original company:

Joseph Ramsey, an attorney and State Senator, who afterward became president of the Albany & Susquehanna Railroad, which is now a part of the Delaware & Hudson system, established the Howes Cave Association. A letter to him from Professor James Hall, who made the first geological survey of the state, covering the occurrence and outcrop of water-lime rock at Howes Cave, is still in existence.

Natural cement was made from water-lime outcropping on the hill at this point in a layer about seven feet thick. The rock was mined and broken up by hammers in pieces weighing in some cases as much as twenty pounds. It was then charged in layers about a foot thick with alternate layers of coke, and sometimes anthracite coal, in vertical kilns having an inside diameter of eight or ten feet, the kilns being built of masonry and lined with fire-brick. At the bottom of the kiln was a sheet iron hopper having grate bars which could be withdrawn as the charge of calcined rock was drawn from the bottom of the kiln. The burned rock was separated and the under-burned and over-burned pieces extracted, while the properly burned material was passed through rotary crackers and then ground between Esopus mill stones to about 50-mesh fineness. One mill was operated by water power and the other by steam power.

Charles H. Ramsey, son of Joseph H. Ramsey, operated the plant of the Howes Cave Association and was one of the first officers of the Helderberg Cement Company. About 1884 he became interested in the possibility of making portland cement from the Howes Cave materials, with the result described elsewhere in this history.

Hiram Snyder, who handled the New York and Rosendale brands, is well and favorably remembered, and unlike many of his Rosendale associates, went into the sales end of the rapidly growing portland cement industry as a part of the Lehigh Portland Cement Company organization.

In western New York there was another group of manufacturers of natural cement. These were possibly more aggressive and venturesome than their rivals in the eastern part of the state. The Bennetts, who had a large plant at one end of Main Street, Buffalo, did an enormous business in the western part of the state. After having excavated their cement rock from nearly a square half-mile of territory, they went out of business, disposing of the land with the cellars excavated for house construction to would-be builders of small homes in the rapidly growing city. That was a sample of the type of men in the Western New York group of manufacturers. A survivor, Lesley J. Bennett, recalls interesting facts connected with the natural cement works in that vicinity known as the Williamsville Cement Plant, which was in operation until about thirty years ago. Mr. Bennett treasures a photograph of the plant taken about twenty-five years ago, showing the mill on the bank of a creek and such interesting details as the old wooden water-wheel and the stone kilns. This mill was built to furnish cement for the Erie Canal locks at Lockport. Mr. Bennett says that, beginning with the Buffalo cement mill's quarry at the north end of

Buffalo, and running through the Williamsville district, the ledge contains fossils, called "Eurypterus," which are found only in the lower Silurian Age. It is said that the only other places in which these fossil remains have been discovered are Genesee Falls, near Rochester, New York, and on an island in the Black Sea off the coast of Russia. These fossil remains vary from a few inches to six feet in length and embrace some forty or fifty varieties. Owing to their rarity, the Smithsonian Institution has collected several hundred specimens. German universities have also collected some of these specimens, having paid as much as from \$200 to \$300 for each specimen.

There were two cement plants at Akron, New York. One of these was headed by Uriah Cummings, a man intensely interested in his business and its development, and the author of a book which is referred to later.

The other plant near Akron, included among its owners, Daniel S. Lockwood, a leading lawyer of Buffalo, an associate of President Grover Cleveland, and a man of widely recognized legal and business ability. During the days of the Wilson Bill, when it was proposed to reduce the duty on cement and admit it to this country under the free list, it was "Dan" Lockwood who served those having tariff matters in charge in the interest of the industry and assisted in having the duty retained.

There were a few cement mills in Ohio, at New Lisbon and elsewhere, but the first big cement center west of Buffalo was at Louisville, Kentucky. Many plants congregated near the Falls of the Ohio, near Louisville and across the river at Jeffersonville, Indiana. John Hulme of Philadelphia and James B. Speed of Louisville were owners of the principal plants in that district. They were foremost in the introduction of new machinery, the development of new methods, and in opening new markets. On their death they left enviable reputations with their associates in the industry. John Hulme left no successor, but the Speed interests came into the hands of William S. Speed, son of the original owner, who, in turn, is making new and bigger successes not only in the manufacture of portland cement, but of "Brix-cement," a revived natural cement.

Under modern methods in the Lehigh district of Pennsylvania, the Coplay Cement Company was a pioneer, although many years before its establishment (about 1850), a small mill was started on the Lehigh Canal at Siegfrieds Bridge, under the ownership of General J. K. Siegfried. It was the outgrowth of this natural cement plant at Coplay that led to the first successful portland cement plant in the United States. David O. Saylor came from the farm to Allentown, Pennsylvania, and associated himself with Adam Woolever and Esias Rehrig. Saylor became interested along with Christian Knauss, a farmer near Whitehall, just above Coplay, in cement rock along the line of the Lehigh River and Lehigh Valley Rail-

road. Mr. Woolever had the reputation of being a leading politician in Allentown and Mr. Rehrig, the County Clerk or Recorder of Deeds, backed Saylor to see what could be done with the material discovered. Saylor, tall, stout, red faced, with a long beard, Rehrig of dark complexion, dark beard and hair, of the same strong physical type, and Woolever, another of like characteristics—these three clear-cut, decided and positive men started to work at their problems by burning the rocks in a little cook stove in Rehrig's office or in Saylor's house. They found that the material would make cement. They secured capital and put up their works at Coplay and from this start they ultimately developed into not only the original producers of portland cement in this country, but owners of one of the large mills in the Lehigh district.

General Siegfried, on the other side of the river, put up a small mill, and through his political connections did a large business on state work and state canals.

Farther to the south, in the Potomac Valley, at Round Top, Maryland, the Waters family, farmers and country storekeepers, erected a cement plant which was very successful and which supplied cement to the Chesapeake & Ohio Canal and to the Washington, D. C., market. At Cumberland, Maryland, another group of men, which included Slack and Gephardt, developed the Cumberland Cement Company, which also found its market along the canal. In West Virginia, on the Potomac River, below Round Top, there was the Shepherdstown works under the control of Blunt. This plant came into its growth after the canal construction days had well passed. Later the Cedar Cliff plant, near Cumberland, was built.

The Lochers of Virginia, some of whom became noted contractors throughout the country, developed the Balcony Falls works in Virginia. The Richmond and Allegheny Canal, so far as masonry is concerned, stands as a testimonial to their success as manufacturers.

The Milwaukee works began with the discovery and manufacture of natural cement by J. R. Berthelet, Sr., whose adventure is described elsewhere. One of the owners of the Milwaukee works was William Plankinton, prominent also in the grain and meat-packing industries. All of these plants produced cement of excellent quality and reputation.

At Utica, Illinois, was a plant owned by the Clark family. Reference to the long and successful operation of this plant appears elsewhere.

On the Pacific coast, a bed of hydraulic limestone was opened up in 1863 at Vallejo, and kilns were built near Benicia. Importations on the coast impeded the development of this plant, but production finally reached 100 barrels a day.

In 1881, natural cement rock was discovered at Canon City, Colorado. Experiments were conducted by M. Megrue, and in 1882 a plant



Twenty years ago quarrying was all done by hand, from drilling the rock to moving the cars. Today, the well-drill, steam shovel and steam train do it much more efficiently and economically.



When rock was loaded by hand, each piece had to be sledged into "one-man" size; consequently, quarry outputs were low. Today, one steam or electric shovel does the work of dozens of men.

was built at Denver. In that year about 100 barrels of cement were made and the following year the first entire kiln of cement was turned out.

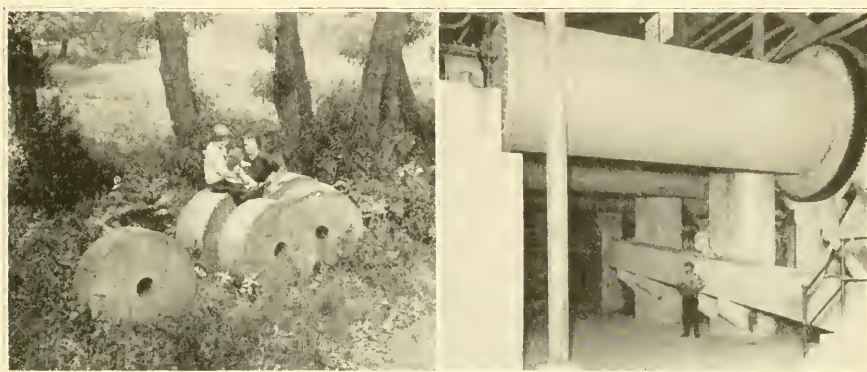
Early Literature on the Natural Cement Industry in the United States

Two books stand out preeminent in dealing with the natural cement industry in this country, namely, that of Uriah Cummings, already referred to, and that of General Quincy A. Gillmore on "Limes, Hydraulic Cements, and Mortars," published originally in 1863 and put through many editions since. General Gillmore was recognized as a man of remarkable scientific attainments, as a government engineer who was largely interested in the use of Rosendale cement in the New York territory, and from his investigations into the Rosendale district spread his inquiries into natural cement plants all over the United States.

Many of the Early Natural Cements Distinguished for Quality

Those who have been in the habit of regarding the old natural cements as of no value and as having been completely superseded by portland cement will find much that is instructive in General Gillmore's book. They will also be surprised at the deserved prestige which early natural cements won. The description of tests and details of the use made of some of the old natural cements on such work as the East River Bridge, government fortifications and other types of construction along the Atlantic coast makes interesting reading.

Considered from the standpoint of output, the Rosendale natural cement district in Ulster County, New York, surpassed all others. Its



In the early days, millstones like these were used to grind and crush the raw material. Tube mills do the work today, the charge of steel balls in one of these mills often weighing as much as a steel freight car.



The modern crusher, to the right, crushes thousands of tons of rock a day, some of the rocks being larger than the ancient apparatus to the left.

remarkable development was due to the excellence of its product and to cheap transportation to New York City and other points on the Hudson River.

The prosperity of the Rosendale industry endured until portland cement had practically supplanted the natural product. A government report in 1896 stated that of all of the natural cements then produced in fifteen states, about half came from New York and nearly all of this from the Rosendale district, with its fifteen plants operated by twelve companies.

How Rosendale Cement Was Named

According to General Gillmore, the Rosendale cement deposits were so named because the stone was first discovered in the township of Rosendale, and were confined chiefly to a narrow belt scarcely a mile wide, following the northwestern base of the Shawangunk Mountains along the line of the Delaware and Hudson Canal in the valley of Rondout Creek.

As described by General Gillmore, the beds occupied "every conceivable inclination to the horizon, being sometimes vertical, seldom on a level, and ordinarily dipping at a greater or less degree either to the northwest or to the southwest. The entire face of the country in this region exhibits unmistakable evidences of having been subjected to a succession of remarkable upheavings. * * * * * The useful effect of these upheavings has been to develop into accessible and convenient positions a vast amount of cement stone that would otherwise have been buried beyond the practicable reach of ordinary mechanical skill."

Various Early Companies Described by Gillmore

Works referred to by Gillmore were those of the Ogden Company and Delafield & Baxter (formerly Ogden & Delafield) at High Falls; the Newark Lime and Cement Manufacturing Company on the Hudson River, at the mouth of Rondout Creek; the Lawrence Cement Company, manufacturers of the Hoffman brand, above Whiteport; the Newark and Rosendale Company at Whiteport; the Rosendale Cement Company, manufacturing the Lawrence brand at Lawrenceville; the Ogden Rosendale Cement Company, High Falls; the works of N. Bruce, at Bruceville, near High Falls; Martin and Clearwater, on the Delaware and Hudson Canal, a few miles from Rondout; Hudson River Cement Company, with quarries five miles from Rondout and mills in Jersey City; Maguire, Crane & Company, a few miles from Rondout; the Lawrenceville Cement Manufacturing Company, Lawrenceville; and Rosendale and Kingston Cement Company, Flatbush.

From descriptions of works it is learned that one company had "seventeen cylindrical (vertical) kilns, * * * * * and the mill driven by steam

power, containing five 'crackers' and eleven run of stone of two and a half feet in diameter, and two run of four and a half feet in diameter. Four of the crackers and five run of stone can grind 800 barrels of cement per day."

The interesting fact to be gathered from writings of Gillmore, Cummings and others is that these cements were essential to the development and construction of the canal systems of the United States and were dependent for their power in many cases upon the waters from the canal itself. Further than this, their storehouses and shipping facilities were on the canal or on the adjacent river, transportation being governed by water conditions.

Early Mill Practice

As to the mill construction of these plants, it may be mentioned that all the kilns, with possibly a very few exceptions, were stone vertical kilns of various heights and diameters into which the raw cement rock was loaded at the top with layers of coal and, in turn, drawn from the bottom into cars which conducted the material to the plant itself. In many cases plant construction was such that the "coffee mill" crushers, which tore apart in the initial step the calcined rocks coming from the kiln, were located on the upper floor of the mill and necessitated tracks on which small cars drawn by wire ropes were conveyed from the drawing floor in front of the kiln to the "coffee mill" crushers. So general was this practice that when a cement manufacturer in later times started to build a plant with crushers on the ground opposite the drawing floor of the kiln, and the crushed material was conveyed in short bucket elevators to the mill stones, the entire neighborhood predicted that the plant would never operate because it did not have an inclined railway from the kiln floor to the crushers, then generally located at the top of the mill.

The other governing factor in early mill construction was that the grinding was performed by old-fashioned buhr stones, or sand stones of the same general type. All these stones required constant dressing, and when one entered a cement mill in those days, he was greeted with a merry chorus of clinking mill picks playing on the hard stones, which required constant redressing at heavy expense.

The So-called Louisville District and Its Extensive Development

The second largest field was that developed near Louisville, Kentucky. The quality of the cement was excellent and its distribution in time covered a wide territory which ranged from Ontario to Florida and from the Atlantic to the Rocky Mountains.

In 1905 a newspaper article referred to the passing of the Louisville cement industry, stating that many of the towns formerly dependent upon the natural cement mills for their prosperity were dead.

The manufacture of Louisville natural cement began in 1829, the year of discovery. John Hulme & Company established works near Louisville, Kentucky, the cement being used in the construction of the Louisville and Portland Canal. For a long time manufacture from the original quarry continued, the cement being sold under the brand of "J. Hulme Star." Mortar made from this cement could be seen in a portion of the original



Every week or ten days one of these old vertical kilns would produce enough clinker to make about 200 barrels of cement, nearly equaling the four-hour output of a modern rotary kiln.

canal wall that remained after a period of sixty years. It was almost as hard as the limestone in the masonry walls, showing no effects of time.

The Hulme mill enjoyed a monopoly of the cement business for many years. The company was without a competitor until 1854, when W. F. Beach erected a mill on the Ohio River, opposite Louisville. After a few years, however, this mill closed down and was finally destroyed by floods.

In 1866, Dexter Belknap, having ascertained that the quality of Louisville cement was excellent, and being impressed with the many advantages to be obtained by the manufacture of cement on some railroad line, built the first cement mill located on a railroad in Indiana. He had traced for some miles north of the Ohio River the strata of rock exposed in the bottom of the river, and located his plant on the J. M. & I. Railroad at a point called Belknaps, so named in his honor. He organized what was

known as the Falls City Cement Company. Manufacture began with a capacity of 200 barrels a day, and in 1892 output was 2,700 barrels daily.

The success of this company encouraged others to seek the advantages of railroad transportation, and in a few years other mills were built. These included the Sabin & Gilmore works, erected in 1867, about eight miles north of Louisville, but finally dismantled.

Prior to 1868 the mills along the railroad were comparatively small. In 1871 the Louisville Cement Company built the Speed Mill at Speeds, Indiana, with a capacity of 700 barrels per day. This mill was operated for a long time, capacity increasing to 4,000 barrels per day. It was known as the largest cement mill in the world. Other important mills were those of Bondurant & Todd, known as the Black Diamond; the works of W. P. Hahn, erected in 1869; the plant of the Falls City Cement Company, erected in 1870.

With characteristic enterprise, the Louisville manufacturers built with reference to future demand instead of current requirements. Business was prosperous, and as time went on additional mills were built, these including the Ohio Valley Cement Company works, near Cementville, Indiana, in 1881; the Kentucky & Indiana Cement Company plant, near Watson, Indiana, in 1887; and the Clark County Cement Company plant, in 1890. Works were also established at Hausdale, Charlestown, and Sellersburg, Indiana, in 1891 and 1892, respectively.

From the single mill of small output erected in 1829 by John Hulme, the number of plants in this locality had increased to eighteen by 1892, having an annual production of a little over 2,000,000 barrels. The production of the entire country in 1892 was a little more than 8,000,000 barrels.

Louisville cement was used in practically all the great engineering works of the time within reach of this field, these including important bridges, water-works, tunnels, locks, dams, street foundations, pavements and sewers.

Natural Cement in the Lehigh Valley District

Third in importance was the Lehigh Valley district, in Pennsylvania. The history of the natural cement industry in the Lehigh Valley district is closely intertwined with that of the portland cement industry. It began with the construction of the Lehigh Coal & Navigation Company's canal along the banks of the Lehigh River from the coal regions to Easton. The first plant established was at Siegfried, Pennsylvania, where General Siegfried, to whom reference has been made, and who afterwards became prominent in public life in Pennsylvania, built a small plant a short distance back from the canal and river. This cement was largely used in the construction of the canal.

On the opposite side of the river, above Coplay station, there was a large hill along the Lehigh Valley Railroad. The face of this hill as exposed by railroad cuts, showed rock similar to that found near the Siegfried works. This led some of the residents to investigate cement-making properties of the material. Among them was the farmer Knauss, to whom reference has been made. He purchased some of the land and endeavored to interest others in it. This property in later years produced some natural, as well as portland cement, and, after the destruction by fire of a small works erected on it, the location became the first works of the Atlas Portland Cement Company. Above this was another small works, known as the Hercules Company, which also made a small amount of natural cement, its site now being that of the Whitehall Portland Cement Company works.

The early developer, however, of the natural cement industry in the Lehigh district was the Coplay Cement Company, the owners of which at that time were David O. Saylor, Esias Rehrig, and Adam Woolever. These men believed that natural cement could be made of the rocks just above Coplay station on the Lehigh Valley Railroad, so they took the material to Allentown, where they lived, and, as previously mentioned, they spent evenings in the house of one of them trying it out in a cook stove, and finally in a kiln they had built. It is related that some of the product was taken down to a flour mill nearby and ground, a characteristic proceeding in the early days of experiment. This cement was known commercially as "Anchor Brand," and in the seventies was largely used for many important works. The Girard Avenue Bridge, and other railway bridges in Philadelphia which carried most of the traffic to the Centennial Exposition of 1876, were built with this cement. After Saylor had perfected the manufacture of portland cement at these works, an addition of portland cement clinker to the natural cement was made, and out of this a mixed cement known as "Improved Anchor" was produced and found large sale.

The Siegfried works had a checkered career, passing through the management of Hugh N. Camp & Sons, of New York, the American Cement Company, A. B. Bonneville and the Allen Cement Company, finally coming into the ownership of the Lawrence Cement Company. In its early days this plant produced natural cement in large quantities. Later an "Improved Shield," a mixed cement, and "Shield," a natural cement, were produced there by the Lawrence Cement Company, the present owners.

The success of these natural cement works in the Lehigh district caused those who in later days were seeking to establish themselves in that field—where in the eighties portland cement was beginning to be manufactured—to search for cement rock of some general character out of which both natural and portland could be produced. This led to the establishment of the American Cement Company, originally the American Improved Cements Company, whose works were on the line of the Ironton Railroad

about two miles back of the Coplay Cement Company and up a small valley leading from Coplay to the iron ore beds at Ironton. This plant introduced the manufacture of "Union" natural cement and "Improved Union" mixed cement at an early day and became large producers of cements which found a market in all the eastern states. They were used on many important engineering works—railroads, dams, bridges, etc. The Johnstown (Pennsylvania) Bridge, celebrated as having withstood the great flood, was built of natural "Union Cement."

Early Natural Cement Works in Maryland and Virginia

Along the Chesapeake and Ohio Canal a number of natural cement works were located. Those at Round Top, about three miles above Hancock, Maryland, and at Cumberland, Maryland, were the principal ones and the pioneers in this field. Both of these plants were located near the canal and the Potomac River, the former plant deriving its motive power from the discharge of the water of the canal into the river. These two companies were largely engaged in supplying cement to the works along the canal, to bridges over the Potomac River, and to Government works in Washington, Baltimore, and Northern Virginia and Maryland. Both made excellent cement, some of which, in Government tests, showed results for long-time periods in sand mortars almost approaching some of the early tests of portland cement under similar conditions.

Another works at Shepherdstown, Virginia, started later. This differed from the other two in that its rock was more highly magnesian than that of the other plants, which had a rather remarkable material for cement making purposes. This company also found a large market for its material in Government work in the District of Columbia and vicinity.

The laying of asphalt pavements in the District of Columbia under the Shepherd and following administrations, provided a large market for all the cements of the Potomac region. Many miles of pavements in Washington, D. C., are laid upon concrete foundations containing natural cement produced in the district mentioned.

In later years a small works which ran for a short period was started at Cedar Cliff, near Cumberland, Maryland.

Of these plants the one at Round Top was the most famous, cement rock having been discovered there in 1837 by A. B. McFarlan, contractor on the Chesapeake & Ohio Canal. The closing down of this plant was announced in 1906.

Milwaukee, Wisconsin, the Center of Natural Cement Manufacturing Activity

Milwaukee, Wisconsin, also became the center of a group of natural cement mills whose founding, as in other cases, was preceded by an acci-

dental discovery of natural cement rock; and, as happened elsewhere, the humble cook stove played an important role. In the early seventies the City of Milwaukee was building a bridge across the Milwaukee River. At that time J. R. Berthelet, Sr., was engaged in the manufacture of cement sewer pipe in Milwaukee. He used Louisville cement, and made frequent visits to that great cement region. There he became familiar with the nature of cement rock and methods of cement manufacture. As a maker of sewer pipe, Mr. Berthelet had occasion to hold frequent consultations at the office of the Milwaukee City Engineer. During one of these visits he noticed samples of rock taken from the bed of the Milwaukee River,



In the early days, cement was stored in bins in this and similar buildings until it was shipped to the consumer in barrels.

where caisson construction had been necessary. Because of its resemblance to the Louisville natural cement rock the specimens aroused his curiosity. Taking samples to his home he burned them in the cook stove. Upon reducing them to powder with a mortar and pestle, he was surprised and pleased to find that he had made a natural cement.

Mr. Berthelet interested a number of intimate friends in plans to exploit the material. Careful test of the rock was made from samples procured throughout the entire area of visible deposit. Samples were sent to all the leading geologists and chemists in the country, their reports bearing out Mr. Berthelet's conclusions as to the adaptability of the rock to the manu-

facture of natural cement. The Milwaukee Cement Company was formed and land on both sides of the river was acquired, the tract extending nearly a mile and a half to the north of the city. Works were erected, and on June 16, 1876, the first barrel of Milwaukee hydraulic cement was manufactured. Output began with about 200 barrels per day, which gradually increased until in 1888 the daily capacity of the two mills owned by the Milwaukee Cement Company was 4,000 barrels.

The first officers of the Milwaukee Cement Company, which was incorporated in 1875, were J. R. Berthelet, Sr., President; George H. Paul, Vice President; John Johnston, Treasurer; Henry Berthelet and Chas. H. Orton, Directors. In 1876, J. R. Berthelet, Jr., resigned his position with the U. S. Engineer's Office, District of Milwaukee, and joined the company as superintendent of manufacture and in charge of construction, in which capacity he served for over thirty years.

About 1890, the Cream City Cement Company was organized, and erected a small mill on the Milwaukee River in the vicinity of the Milwaukee Cement Company's plant. The Cream City Company manufactured under the brand of "Cream City" cement, but after a time the plant ceased to operate.

A few years later another Wisconsin cement company was organized under the name of the Consolidated Cement Company. A mill was built on the shore of Lake Michigan, north of Milwaukee, where an outcropping of natural cement rock was available. Owing to excessive cost of manufacture, the venture was not a success financially, and after a few years was discontinued.

The advent of the rotary kiln was followed by rapid development of the portland cement industry and a corresponding decline in the natural cement industry. The Milwaukee district began to feel the effects of the change as early as 1905, and in 1909 the Milwaukee Cement Company ceased to manufacture natural cement.

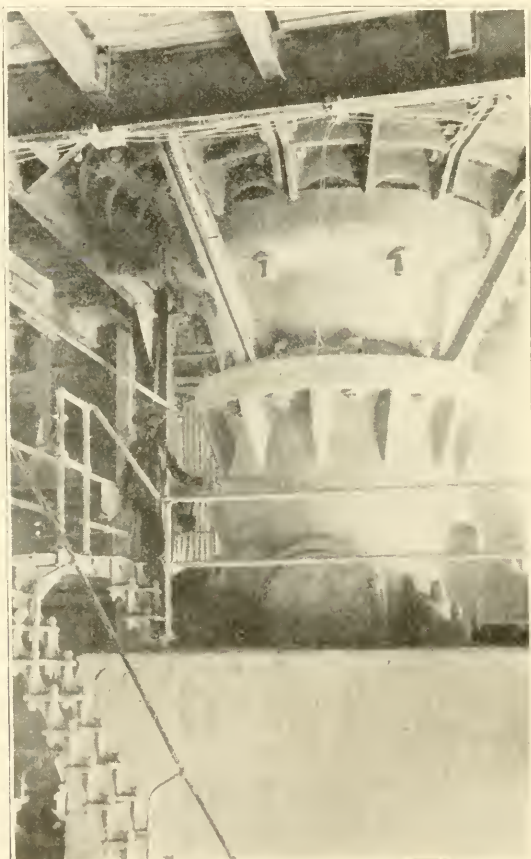
Early Natural Cement Developments in Minnesota, Michigan and Illinois

Among the early natural cement centers was Mankato, Minnesota. Works were established there in 1883, and the locality has been identified with the industry since that time. Of the first Mankato plant, Cummings says that it was of stone and presented a fine and substantial appearance. He adds that the cement rock was of the very best quality, the manufactured product obtaining a strong foothold in the markets of the Northwest, where it was extensively used in municipal, railway and miscellaneous construction throughout several states. Cummings says that the mortar from this cement became exceedingly hard and stone-like in character,

whether above or below water, and withstood to a remarkable degree the effect of alternate freezing and thawing. In 1901 the Mankato cement works had a capacity of 1,200 barrels per day.

Among the well-known manufacturers was Patrick Carney, who died some years ago. The Carney Cement Company is still operating at Mankato, with H. E. Carney, a son, as president.

It is said that an attempt to manufacture natural cement was made at Trowbridge Dam, on Thunder Bay River, seven miles northwest of



Rock crushers nowadays weigh as much as 450,000 pounds, or equal to the weight of three steel Pullman cars.

Alpena, Michigan, in 1866. Wood was used for fuel. Owing to the poor quality of the material the enterprise was not successful.

Some of the southern and western plants survived long after many in the east had been abandoned. For example, N. J. Cary, of Utica, Illinois,

until recently actively interested in cement, wrote as follows on June 25, 1920:

In 1838, the late Hon. James Clark, of Utica, La Salle County, Illinois, commenced the manufacture of hydraulic cement here, where it was used in the construction of the Illinois and Michigan Canal, and the works have been in continuous operation from that time to this. During this period they turned out many million barrels of cement, the most prosperous time in that industry being from 1880 to 1906. Of late years the industry has been almost entirely superseded by the portland cement industry. Utica cement is still manufactured here, however, although on a smaller scale. The Utica Hydraulic Cement Company succeeded Mr. Clark in the manufacture of cement in 1883, and still continues its manufacture.

While the greater part of this chapter relates to large and important natural cement regions and the use of the product in canals and large engineering works, successful manufacture on a small scale was sometimes undertaken to supply local demand for cement. Kensington, Connecticut, had a plant of this character, which manufactured for many years, and it was said the cement made there showed marked superiority in stucco work. Expensive land transportation prevented it from coming into competition with the Rosendale cements. The Kensington rock was discovered in 1826.

Uriah Cummings Traces History of Natural Cement Industry

In his book published in 1898 under the title of "American Cements," the late Uriah Cummings, long prominently identified with the cement industry, gives an exceedingly valuable and comprehensive history of the natural cement industry. The book contains much that would have been lost save for his indefatigable industry in collecting and publishing important facts. He relates many interesting incidents connected with the early production of natural cement in the United States. As an instance, he says that a clergyman, Rev. Charles W. Howard, of Charleston, South Carolina, discovered cement rock in Cement, Georgia, and associated with him in an analysis of the rock was the distinguished chemist, St. Julien Ravenel, of Charleston, intimate friend of Professor Agassiz. Howard and his son manufactured cement until the breaking out of the Civil War. In 1867 Col. George H. Waring, of Savannah, Georgia, took over the plant, which operated as the Howard Hydraulic Cement Company. Concerning the quality of this cement, which was very superior, plaster made from it and applied by Dr. Ravenel to the exterior of his house on the Charleston Battery in 1852 remained unimpaired until long after the sandstone lintels of the windows had disintegrated. The plaster was still intact in 1898.

Of these old natural cements, Cummings says no other country in the world had cement rocks which compared favorably in any sense with those so well distributed throughout the United States.

In 1895 he contributed the chapter on natural cement appearing in the United States Geological Survey Report. Writing of European sources of supply he says:

No experienced cement manufacturer in America would undertake to produce a rock cement from such a mixture of clays, shales, marls, nodules, limestones and cement stones. * * * * * Contrasting these materials with our own massive cement-rock deposits, we find that we have immense beds of cement rock, absolutely free from any extraneous substances, perfectly pure and clean, with layer upon layer extending thousands of feet without an appreciable variation in the proportion of ingredients. Cement-rock quarries are worked in this country decade after decade without the necessity of rejecting a pound of the material, and the analyses taken during successive years show no marked change whatever in the constituent parts. Had England and France possessed such cement-rock formations as are so well distributed throughout this country, it is extremely doubtful if the production of artificial cement would have been resorted to. Under such circumstances there would have been no occasion for it.

The following table gives the more important discoveries and uses of American natural cements in chronological order:

DISCOVERY AND EARLY USES OF NATURAL CEMENT IN THE UNITED STATES

YEAR	LOCALITY	CONSTRUCTION
1818	Fayetteville, N. Y.....	Erie Canal
1824	Williamsville, N. Y.....	Erie Canal
1826	Kensington, Conn.....	Miscellaneous
1828	Rosendale, N. Y.....	Delaware and Hudson Canal
1829	Louisville, Ky.....	Louisville and Portland Canal
1831	Williamsport, Pa.....	Muney and Lock Haven (Pa.) Canal
1836	Cumberland, Md.....	Miscellaneous
1837	Round Top, Md.....	Chesapeake and Ohio Canal
1838	Utica, Ill.....	Illinois and Michigan Canal
1839	Akron, N. Y.....	Miscellaneous
1848	Balcony Falls, Va.....	Miscellaneous
1850	Siegfried's Bridge, Pa.....	Easton and Mauch Chunk Canal
1850	Cement, Ga.....	Miscellaneous
1863	Vallejo, Calif.....	Miscellaneous
1867	Fort Scott, Kans.....	Miscellaneous
1869	La Salle, Ill.....	Miscellaneous
1869	Howe's Cave, N. Y.....	Miscellaneous
1874	Buffalo, N. Y.....	Miscellaneous
1875	Milwaukee, Wis.....	Miscellaneous
1881	Canon City, Colo.....	Miscellaneous
1883	Mankato, Minn.....	Miscellaneous

The consumption of some of the cements whose uses are designated in the above list as "miscellaneous" was very large, construction including many important engineering works other than canals.

The status of the several natural cement districts at the time maximum production was at hand is shown by the following table, published in 1898, at which time something like 100 works conducted by 70 different firms

or companies were operating in 14 states. While the total in the production column differs slightly from that appearing in the large official table covering all cements, published elsewhere, it is sufficiently close to show that the figures are substantially correct.

PRODUCTION OF NATURAL ROCK CEMENT DISTRICTS IN 1898

DISTRICT	Number Concerns	Barrels Produced	Per Cent of Total
Rosendale, Ulster County, New York	15	3,500,000	41.9
Louisville, Kentucky and Indiana	15	1,750,000	20.9
Lehigh Valley, Pennsylvania	6	750,000	8.97
Erie County, New York	4	550,000	6.59
Illinois	2	550,000	6.57
Milwaukee, Wisconsin	1	475,000	5.68
Maryland and West Virginia	5	275,000	3.28
Schoharie and Onondaga District, N. Y.	10	200,000	2.39
Kansas	2	140,000	1.68
Minnesota	2	85,000	1.02
Ohio	3	35,000	0.42
Virginia	3	20,000	0.24
Georgia	1	15,000	0.18
Texas	1	15,000	0.18
TOTAL	70	8,360,000	100.00

Natural cement production in America from the time the rock was discovered by White in 1818, is given in the table on page 72 in conjunction with portland and puzzolan cements. For the figures on early production tribute is again due Uriah Cummings. For thirty years he worked assiduously in collecting, sifting and compiling data not then considered by the Government sufficiently important to record, and to him alone is the country indebted for the only reliable early natural cement statistics extant.

Mr. Cummings, who was born at Akron, New York, in 1833, subsequently removed to Stamford, Connecticut, where he died on November 11, 1910. At the time of his death he was president of the Cummings Cement Company of Akron. He was an authority on many questions relating to cement and concrete, and for years had charge of Government investigations relating thereto. He was a frequent contributor to technical magazines and other publications on scientific subjects, and the inventor of a great many successful mechanical devices. Aside from technical matter, he wrote tales, both historical and fanciful, dealing chiefly with the Indians of western New York, in whom he was greatly interested. His life represented a long period of industry and usefulness.

CHAPTER III

DISCOVERY OF PORTLAND CEMENT

England the Birthplace of Portland Cement

Portland cement originated in England. Before its discovery, extensive manufacture and use of natural cements prevailed in England. Many were attempting to improve these natural cements and numerous patents were granted. In an account of the development of the natural cement industry up to about 1818, Henry Reid, a distinguished English civil engineer and author of important works on cement, in his book "Portland Cement, Its Manufacture and Uses," published in London in 1877, says:

All experiments up to this period (1818) apparently aimed only at the obtainment of a resulting product from the kiln which should, in its leading characteristics, approach the quality of lime fresh burnt. Instead of driving the mixture to the point of vitrification, all operations were so conducted as to studiously avoid such a result, and when, by accident, this occurred, the pieces so hardened were carefully rejected as worthless.

Early Experiments of Aspdin

This avoidance of vitrification, as described by Reid, was getting away from portland cement. But in 1824 Joseph Aspdin, an English bricklayer who had been experimenting since 1811, took out a patent on an improved cement which he called portland cement because it resembled in color the Isle of Portland building stone. This was his second patent, the first covering specifications for "An Improvement in the Modes of Producing an Artificial Stone," which patent was practically the first scientific description of an artificial portland cement.

In his early experiments Aspdin used hard limestones found near his plant, and struggled along for some time trying to make out of these and clays something which he thought would be a hydraulic cement. At this time he did not have quite the idea of a portland cement, but he ultimately got it by burning his hard limestone at higher temperatures.

About 1845, there were two strong factions at work in England. On one side was John Bazley White, who was making Roman and Frost's Cements, the latter a lightly calcined artificial cement. On the other side was William Aspdin, son of Joseph Aspdin, making portland cement, who, after securing some financial backing, came down to the Thames district and used the soft clay and chalks found there for the manufacture of his product, and ultimately formed the firm of Robbins, Aspdin & Company.

Concerning preceding experiments and patents of others and the patent obtained by Aspdin, Reid writes as follows:

While all these patentees and other experimenters in England, France and Germany were simply seeking, and indeed were apparently satisfied with an artificial hydraulic lime, Aspdin went beyond, and gave the grand finish to the whole by his discovery of the increased temperature of the kiln, and consequent high specific gravity of the cement, now no longer regarded as a simple hydraulic lime.

This would seem to prove that Aspdin was the first to discover portland cement, but further along Reid makes finer distinctions. He says it is difficult to attribute to any one of the numerous experimenters the credit of inventing portland cement, but adds:

We find differences, however, in the value of the assistance rendered at the various stages of progress, and Aspdin, although the least distinguished of all of them persevered in bringing to our knowledge the importance and, indeed, necessity, of a high temperature in the kiln.

The story of the discovery of portland cement might be dismissed with the foregoing account were it not for the fact that discussion of the subject was revived in England and in this country in 1911, nearly a century after Aspdin obtained his patent. In June of that year, Isaac C. Johnson, of England, who had long been prominent as a manufacturer of cement, and who was then well along in his 101st year, wrote to the editor of *Cement Age*, New York, claiming to be the "first manufacturer of a cement that would pass the tests of the exacting engineers of British and foreign governments." Johnson also says:

I grant that the name "portland" is due to Mr. Joseph Aspdin when he took out a patent in 1824, but which is no more like the cement that is made today than chalk is like cheese.

Dr. William Michaelis, Sr., in a review of the subject published in *Tonindustrie Zeitung* of March 24, 1905, gives great credit to Johnson as having "placed the child, so long weakly and helpless, on its feet," and says:

The communications of this eye-witness (Johnson) and an exhaustive study of English technical literature, especially of that of the first half of the last century, have now led to the certainty that the contention that J. Aspdin was the discoverer of portland cement cannot be maintained.

Old newspapers, circulars, and advertisements reveal incidents relating to the early manufacture of portland cement in England that are full of human interest. The same jealous rivalries that marked the beginning of the industry in the United States prevailed in England, and concerning the Aspdins—Joseph, who invented a cement called portland in 1824, and his son, William, who also became a manufacturer—simple justice demands recording the fact that they kept their competitors guessing and on the

jump. Even Isaac C. Johnson becomes a most entertaining witness in support of this statement. In the Building News of London, there was published in 1880 an abstract of a statement prepared by Johnson in that year for G. R. Redgrave, British engineer and author of "Calcareous Cements," from which the following extracts are taken:

Mr. Johnson states that about 1845 young Äspdin

—began work at Rotherhithe in connection with Messrs. Maude & Son on a small scale, and did sometimes make a strong cement, but owing to want of scientific method, the quality as respects strength and durability was not to be depended upon.



Swinging hammers in the hammer mill batter the rock from the crushers into pieces small enough for the preliminary grinders. The impact sounds like machine-gun fire.

of his later partners, that the process was so mystified that anyone might get on the wrong scent—for even the workmen knew nothing, considering that the virtue consisted in something Äspdin did with his own hands.

Thus he had a kind of tray with several compartments, and in these he had powdered sulphate of copper, powdered limestone, and some other matters. When a layer

I was at this time (about 1845) manager of the works of Messrs. White, at Swanscombe, making only the Roman Cement, Keene's Plaster, and Frost's Cement. * * * My employers, attracted by the flourish of trumpets that was then being made about the new cement, desired to be makers of it, and some steps were taken to join Äspdin in the enterprise, but no agreement could be come to, especially as I advised my employers to leave the matter to me, fully believing that I could work it out.

As I said before, there were no sources of information to assist me, for although Äspdin had works, there was no possibility of finding out what he was doing, because the place was closely built in, with walls some 20 feet high, and with no way into the works, except through the office.

I am free to confess that if I could have got a clue in that direction I should have taken advantage of such an opportunity, but as I have since learned, and from one

of washed and dried slurry and the coke had been put into the kiln, he would go in and scatter some handfuls of these powders from time to time as the loading proceeded, so the whole thing was surrounded by mystery.

What then did I do? I obtained some of the cement that was in common use, and, although I had paid some attention to chemistry, I would not trust myself to analyze it, but I took it to the most celebrated analyst of that day in London, and spent some two days with him. What do you think was the principal element according to him? Sixty per cent of phosphate of lime! All right, thought I, I have it now. I laid all the neighboring butchers under contribution for bones, calcined them in the open air, creating a terrible nuisance by the smell, and made no end of mixtures with clay and other matters contained in the analysis, in different proportions and burnt to different degrees, and all without any good result.

Thus, according to Johnson himself, Aspdin was a conspicuous figure in the cement world at the time—one whose secrets others sought to discover. Johnson goes on to describe subsequent experiments which led to the production of a good portland cement.

Another interesting fact is that in 1851, when the first of the great expositions was held, there were shown samples of portland cement, and Pasley—who was the grandfather of all the ideas concerning hydraulic limes—for the first time knew that Aspdin had taken out a patent in 1824 on what he himself had written about in 1820.

Engineering records in England contain many accounts of experiments with natural and portland cements in the early fifties. The great controversy that had been going on between the exponents of these rival cements ended in a victory for portland cement. Natural cement was eventually driven to the wall and the portland cement business became a thriving industry in England.

Having presented impartially the recorded claims of those who aspired to the honor of having invented portland cement, it would be remiss not to refer more fully to John Smeaton, the first to rediscover the source of hydraulicity in limestone, and who, in this earlier field of endeavor, was the greatest figure of his time.

Dr. Michaelis' publication of 1869 says:

A century had elapsed since the celebrated Smeaton completed the building of the Edystone Lighthouse. Not only to sailors, but to the whole human race, is this lighthouse a token of useful work, a light in a dark night. In a scientific point of view it has illuminated the darkness of almost two thousand years. The errors which descended to us from the Romans, and which were even made by such an excellent author as Belidor, were dispersed. The Edystone Lighthouse is the foundation upon which our knowledge of hydraulic mortars has been erected, and it is the chief pillar of modern architecture. Smeaton freed us from the fetters of tradition by showing us that the purest and hardest limestone is not the best, at least for hydraulic purposes, and that the cause of hydraulicity must be sought for in the argillaceous admixture.

Contemporaneous with the early technical research of British engineers and cement manufacturers was advanced thought along other lines, which

we, in this day, are likely to regard as altogether modern. As an illustration, there is found in Reid's book the following paragraph relating to workmen:

Before entering on the discussion of the various cement-making materials, we are desirous of calling attention to the desirability of inculcation in the minds of the operatives the advantage, if not the necessity, of acquiring something more than a simple external or surface knowledge of the materials passing through his hands, and in the conversion of which he plays so important a part. * * * * * Is it creditable in this age of intelligence that the operative cement maker while dealing with the simplest of minerals should exert only mechanically the aid required of him, and continue debarred by his ignorance from appreciating the nature of these materials and the original sources from which they are derived. * * * * * Hard work is made harder when pursued without interest. It is the wearisome, uncongenial task that ultimately breaks down the most elastic mind.

This philosophy, which has a thoroughly practical as well as an altruistic side, was proclaimed nearly half a century ago.

The chronology of important events leading up to the discovery and manufacture of portland cement is given by Reid as follows:

1756—John Smeaton, who sought a special cement for his own purposes.

1780—Dr. Higgins, who was chiefly interested in stucco.

1796—Parker. Important discovery of converting the nodules (septaria) found in the London clay.

1810—Edgar Dobbs. Contributed to the mechanical knowledge of the subject.

1818—Viêt, John, Treusaart and St. Leger, foreign contributors to chemical knowledge.

1824—Joseph Aspdin. Experiments revealed importance of high temperatures in kiln.

1826—Sir C. W. Pasley. Conducted many important experiments.

1826—Frost. The first to erect a factory near London for the manufacture of portland cement for construction purposes.

The manufacture of portland cement found its way to Belgium, where Edward Fewer, who had married a daughter of Joseph Aspdin, started its manufacture near Antwerp.

Other countries gradually took up its manufacture, the first plant in Germany being the Lossius & Dellbrück plant, established in 1855, near Stettin. France also started the production of portland cement, there being at Boulogne, one of the largest works in Europe.

The manufacture of portland cement in Europe grew rapidly. European producers began to find numerous new uses for their material in sidewalks, buildings, artistic construction, docks, etc.; and engineers, familiar with world problems, soon began to realize the enormous possibilities that the development of this new material for building construction possessed. Consequently, along in the early eighties, Europe began exporting portland cement to North and South America and to other parts of the world.

CHAPTER IV

IMPORTED PORTLAND CEMENT IN THE UNITED STATES

Influence of Post-Civil War on Growth of Portland Cement Industry

With the development of the United States after the Civil War, construction began to grow rapidly. The building of the great railroads to the Pacific had developed large territory and produced great wealth.

After the Jay Cooke panic of 1873, the country began to realize the financial benefits of reconstruction and of the commercial development that took place in the early eighties. It was but natural, therefore, that in the desire for more substantial buildings of greater height and larger foundations, in the desire for bigger and stronger bridges, in the wish for better and more permanent sidewalks and roads, and better work generally along artistic lines, that the engineer and the constructor should turn to the uses of portland cement in Europe, and that they should seek to obtain a wider use of it in this country.

There had been some importations of portland cement in the United States recorded as far back as 1868, but the quantity was insignificant and little was known of this then comparatively new cement and its manufacture. The interested student of the material in this country had at the time but a single book of reference in the English language, namely, the work of Henry Reid, published in London, in 1868. Engineers and builders were practically dependent for such information as could be had on portland cement upon papers of Grant on the London sewerage system, Bamber on various engineering work in England. Beyond this there was only an occasional paragraph in the technical press telling what could be done with portland cement.

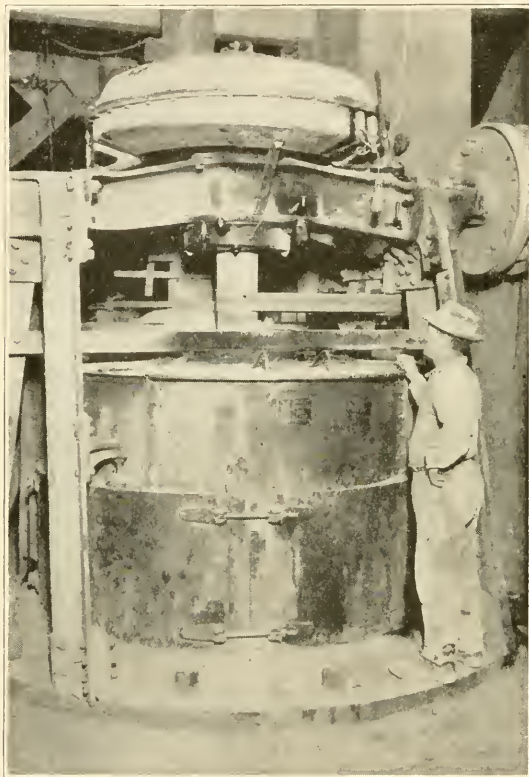
As time went on, however, the reputation of portland cement abroad continued to increase through its growing use in the construction of docks, public works, miscellaneous buildings, sidewalks, etc. Through engineering publications and the practical knowledge of engineers acquired in Europe and who came to this country to engage in various engineering enterprises, the reputation and fame of portland cement spread among American engineers and builders.

Interest was further increased by the rapid development going on in the United States following the readjustment period after the Civil War. In the construction field this was marked by more pretentious buildings,

which meant structures of greater height and therefore requiring larger foundations, intensive programs of city street improvement, which included street paving and sidewalks. The well-known paving contractors of the time, among whom were Filbert and Drehman of Philadelphia, the Stewart

Granolithic Organization of New York, Cranford of Washington, D. C., and a large number of their followers, who had begun to build concrete sidewalks, demanded portland cement for the purpose, because of the reputation which it had already gained as a superior product. There was also a large demand from Germany, where it was used for concrete floors in breweries.

In 1878 importations of portland cement totaled 92,000 barrels. From this they grew to 106,000 in 1879, to 187,000 in 1880, and by 1885 to 554,000 barrels. In 1888, which marked the end of a ten-year period, importations were 1,835,504 barrels.



The centrifugal type of grinding mill uses great swinging rollers, rotating rapidly, to crush the material between them and the outer die.

Importations of Portland Cement Often Came as Ballast

With these figures in mind, it is a matter of considerable interest in connection with the history of the American portland cement industry to describe the methods by which this large importation was handled. In those early years the usual cargo ship was a wooden sailing vessel. Barques or full rigged ships were generally employed. These had no auxiliary power, and when sailing without regular cargo required ballast of sand, stone or other material to stabilize the ship. These vessels differed entirely from the liners which carried expensive cargoes from Europe, and which, being constructed of steel or iron, had compartments that were filled with water

ballast when necessary and discharged when taking on cargo. The vessels in the cement-carrying trade were of the type known as tramp cargo ships. In most cases they came to the United States to get export cargoes of grain or cotton. Such cargoes paid high revenue. Instead of non-paying ballast (as there was little inbound paying cargo to this country) they took on cement or other heavy material. The result was that freight from European ports to this country on cement was very low. In some cases the American consignee was not only able to get his cement brought across the Atlantic free of charge but was actually paid by the ship as high as ten cents a barrel for the unloading of it. This occurred at times when the outgoing grain paid such good rates that the tramp ship, in order to take advantage of the market, was obliged to get the cargo she had carried over discharged rapidly, even if necessary to pay for unloading.

The points of heaviest importations of foreign cements were New York, Philadelphia, Charleston, Savannah, New Orleans, Galveston, and some Pacific Coast ports. In the last case, not only did Belgian, German and English cements come to the Pacific Coast as ballast for grain ships, but also cements from Japan and China.

As these ships had no regular sailing dates, and because they were sailing vessels, had no definitely known time of arrival, the successful marketing of foreign portland cement required far-seeing calculations. A ship would be loaded in London or Hamburg. Its actual arriving time was governed by the elements, and was a most uncertain factor. The cements would be consigned to various importers representing the manufacturers, and one importer might have a consignment of one brand and another importer an equally large lot of another brand, both on the same vessel. Thus it became a contest of wits to dispose of the material promptly. This had to be done to secure discharge from the ship at the earliest possible moment so as to avoid storage, demurrage and other unnecessary expenses. The result was that each importer was constantly endeavoring to secure orders for shipments to arrive, and when an excess of material would reach the harbor on several vessels at the same time, they had to go on the building material exchange and find customers who would take it off their hands at the earliest possible moment. The business was uncertain as to possible profit and sometimes entailed considerable loss.

Among the Early Importers

In the early days James Brand, a keen Scotchman, was the importer of the best English brands, such as "Knight," "Bevan & Sturge," "Burham" and other cements of high reputation. Brand was straightforward in his dealings and rigid in his ideals of business methods. His office was a model of old-time business methods, accuracy, promptness and care.

He dealt not only in portland cement, but was also an importer of hatters' furs, asphalt, and other commodities. In later years, he became one of the original stockholders in the American Cement Company, at Egypt, Pennsylvania.

Another large importer was Howard Fleming, who handled the "J. B. White" brand, and later several German cements. Buoyant, joyous, hopeful, Fleming was always a welcome visitor and had a large following among buyers.

Sinclair & Babson was another firm of importers. Robert S. Sinclair of this firm was a graduate of Mr. Brand's office, where he had charge of the cement importing department. This firm represented for many years the great Alsen Company of Germany. Its trading extended all over the United States, as its cement was high in favor of leading engineers. Later, when the Alsen Company decided to build an American plant on the Hudson River, near Catskill, New York, Mr. Sinclair was associated with the company in its management. At this writing he is president of the Park Commission of Newark, and has contributed the following interesting narration:

My acquaintance with portland cement began in 1871, but previous to that time the firm of Hammill & Gillespie, 240 Front Street, New York, had been importing portland and Roman cement from England in small quantities, and I fancy were the actual pioneers. Their business was in English china clay, fire bricks, chalk, Fullers earth, and kindred articles, so it was quite fitting that they should import cement. Their call had, however, been more for Roman, than for portland cements and the former was placed first upon their sign as being the more important in their estimation. It is refreshing and very unusual in business annals in our country to find that this firm is still engaged in the same business at the same address.

In 1871 I was a sort of lob-lolly boy for the firm of S. L. Merchant & Company, ship brokers, at 76 South Street, New York. They had shipping connections in London who occasionally loaded vessels with general cargo for New York, consigning the ships to Merchant & Company. It was during 1871 that they loaded the ship *Asiana* in London for New York, and being unable to obtain sufficient freight to make a full cargo, they put on 500 barrels of J. B. White & Brothers portland cement, consigning them to S. L. Merchant & Company with instructions to sell them as advantageously as possible, credit the ship with freight on them, and remit the proceeds to the London firm. Upon arrival of the ship, it was found that little was known about portland cement—there were no brokers or commission houses through whom it could be sold—and so Mr. Merchant tried one clerk after another in his employ to get them to try to sell the cement to masons and contractors; but they got out of it upon one pretext or another. He finally got down to me at the bottom of the list and ordered me to try to get rid of the cement. When I found that I was expected to get \$6 per barrel in competition with Rosendale cement selling at about \$2, I felt that I was up against the impossible, especially as I had not the slightest knowledge of their comparative merits. But I was so fortunate as to soon come into contact with a more than ordinarily intelligent mason builder, Marc Eidlitz, who kept in touch with developments in building trades in Europe, and therefore knew something about portland cement. He was desirous of trying some of it in work then under way. Through his advice and introduction, I was able to

interest others in making small purchases, until finally the entire 500 barrels were sold, one sale I remember being to W. T. Klots & Brother, Brooklyn dealers in building materials. I do not know whether that was the first portland cement bought by New York dealers in building materials. The net returns for the 500 barrels must have been satisfactory to the London shippers as other shipments followed and in a short time S. L. Merchant & Company began importing on their own account.

In the meantime, the New York Department of Docks, 1871-72, under the administration of George B. McClellan, Chief Engineer, had perfected plans for building a bulkhead wall of portland cement concrete on the North River, but found it impossible to obtain any dependable quantity of cement in the New York market. One of the Dock Commissioners had, as a neighbor, James Brand, a commission merchant having a London office, and the Department arranged with him to import the cement for them, paying him 5 per cent commission. The brands imported were "J. B. White & Brothers," and "Burham," made by The Burham Brick, Lime & Cement Company.

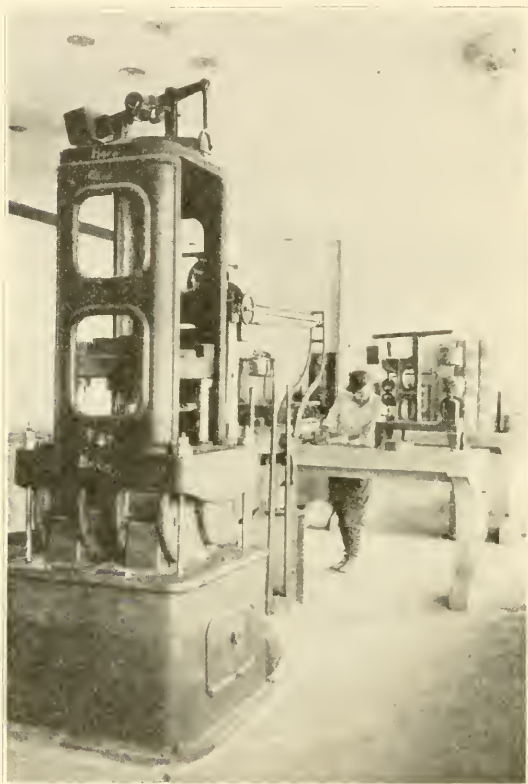
John J. Schillinger at about the same time obtained a patent for a cement sidewalk made with an expansion joint, and learning of the Dock Department's arrangement with James Brand, he also arranged with Brand to import cement for him on a commission basis. Early in 1873, being dissatisfied with S. L. Merchant & Company's business methods, I suggested to James Brand that he could build up a worth-while business in importing cement for sale to the general trade, and he at once engaged me to manage that department of his business. We imported "J. B. White & Brothers," "Burnham" and "K. B. & S." (Knight, Bevan & Sturge). The business grew rapidly and was continuously profitable.

During the first half of the decade 1870-80, my recollection is that only English cements were imported with the exception of a French cement brought from Boulogne by the Coignet Stone Company of Brooklyn for its own use. In those years the New York Department of Docks was practically the only buyer requiring that cement should be subject to test. My recollection is that the tests were only two, namely: A tensile strength of 250 pounds per square inch after seven days when mixed neat, and that 75 per cent should pass through a sieve having 2,500 meshes to the square inch. Captain W. W. Maclay, Assistant Engineer, supervised the tests made by the Department, and he probably did more than any one individual in those early years to raise the standard of quality in portland cement.

In the early years, all importations came in sailing vessels, the cement being packed in barrels having a gross weight of 400 pounds. Almost every cargo had a portion damaged by water, owing to leaky ships. Occasionally the damage would amount to a large percentage of the entire cargo. Freight from London to New York or Philadelphia ran from 25 to 40 cents per barrel, fluctuating according to amount of ship room available, occasionally dropping as low as 15 cents per barrel. Upon one occasion I brought a cargo of 3,000 barrels from Hamburg to New York for the nominal sum of one dollar.

In 1876 or 1877 German cements began to appear, Dyckerhoff, Alsen and Star (Stettin), and it was soon discovered that they were of better quality than the English cements, being finer ground and of greater tensile strength. There followed a gradual discrimination in their favor. When English manufacturers were informed of the superiority of German cements, they ridiculed the statement and declined to entertain the suggestion that they should institute similar improvements in their own manufacture, saying with characteristic English manner that they were following exactly the same methods employed for the past thirty years and they could see no reason for changing. The result was that the English cements ultimately were entirely supplanted in this country by German and Belgian brands, the former because of superior quality, the latter because of low price.

During the first decade importation by steamer became necessary as the demand could not be supplied by sailing vessels alone, nor was their time of arrival sufficiently dependable. The Alsen Company was the only one so far as I know that attempted shipments in bags. A few shipments were made by steamer to New York in jute gunny



Interior of a cement plant physical laboratory. Men are at work here, night and day, testing samples of the raw materials and the finished product.

bags containing 188 pounds of cement, two to the barrel, but they were too heavy to be conveniently handled and the experiment for general trade purposes was soon abandoned. However, the large quantity of Alsen cement used by the Florida East Coast Railway in building the viaduct toward Havana, was shipped in bags by steamer direct to Key West. In that case the cement went directly from the steamer to the work with the minimum of handling and the bags did not meet with serious objections, especially as they effected a considerable saving over cost of barrels.

The Alsen Company was the only one, to my knowledge, to make the experiment of shipping cement in sheet-iron drums. They were cheaper to make than a wooden barrel but being perfectly straight, without any bilge, they were awkward to handle and were discontinued.

During the decade 1890-1900 it became evident that imported portland cement

would soon be supplanted by our home product, and manufacturers abroad were faced with the alternative of giving up their trade and good will in this country or building a plant in the United States. The Alsen Company decided to do the latter and on September 26, 1900, there was filed with the Secretary of State in New Jersey the certificate of incorporation of Alsen's American Portland Cement Works, with Heinrich Wessel as President; Heinrich Wulf, Vice-President; Herman Baasch, Treasurer; Robert S. Sinclair, Secretary.

The incorporators were Heinrich Wessel, Herman Baasch, Heinrich Wulf, Arthur C. Babsen and Robert S. Sinclair. Their mill was located on the Hudson River, six miles below the town of Catskill, their property immediately adjoining that of the already established Catskill Cement Company.

Importations continued, however, in a small way until the war with Germany brought them to an end. My recollection is that importations of all brands never exceeded four million barrels in any one year.

Emile Thiele, a tall, slim, military type of German, controlled the importation of the well-known Dyckerhoff and other German brands, the Hilton English brand, and several Belgian cements. Thiele's office, as well as Mr. Thiele himself, conveyed the impression of German military discipline and accuracy. Dependable, systematic, careful marketing was evident to every visitor, and Thiele had representatives devoted to him personally in all the large cities of the country. Today he is living in New York the life of the successful retired business man.

Batjer & Meyerstein also had a large business, as did Charles J. Stevens, who represented the Brooks-Shoobridge English cement.

A very important figure in the importing business, though possibly he might better be classed as an exporter, was Charles Zunz, whose headquarters were in Brussels. He was a merchant prince with trade all over the world, dealing in cement, steel, plate glass and other Belgian products, and importing into his own country grain, oils and other materials from the United States and South America. His dealings were marked by unfailing courtesy and high sense of business honor. He was characterized by his broad view as a merchant, his willingness to take a loss, and his desire, in every case, to protect his customers and deal fairly with them. Of him Charles Weiler, of the Western Lime & Cement Company, Milwaukee, writes as follows:

He was an ideal salesman, speaking a very precise English, and neither eager nor argumentative over portland cement problems, so that I found it a pleasure to deal with him. I at once called upon him and found, for the first time, that he was a very important plate glass manufacturer, having a large office with about fifty or sixty clerks, every one of them able to speak three or more languages. Mr. Zunz represented cement only as a small side issue, and this evidently accounted for his indifferent attitude in trying to make cement sales in America. After a pleasant hour's talk he volunteered to show me the beautiful Parliament Building opposite the King's Palace, across the park, explaining that Parliament was not in session, and, as a stranger, I would be denied admission. I noticed that the armed guards bowed deferentially to Mr. Zunz as he piloted me through halls and splendid rooms; but the reason was not evident until we entered the small and richly beautiful Senate Chamber—equivalent to the House of Lords in London, as it was reserved for the titled nobility. Then he stopped in front of a conspicuous blue-velvet arm-chair, and quietly said: "This is my seat." I glanced at the polished plate on the chair arm and saw that it read "Le Baron Charles Zunz." At the hotel later I learned that he was one of the wealthiest men in Belgium and a Peer of the Realm. He was also a kindly, pleasant, democratic, plain citizen, and an honor to the Portland Cement Industry.

An interesting recollection of many years' dealing with all of these importers is how much they were governed in their methods by the manners and customs of European business men. In many cases the letters that

went out of their office were hand-written by the principals, being copied in old-fashioned letter books. The typewriter had great difficulty in finding its way into the offices of these great importing concerns. The efficiency engineer would have had the door shut in his face, but the efficiency was there without the interposition of the engineer. All their work was done with accuracy and dispatch, and an unfailing sense of responsibility seemed to permeate the atmosphere of their offices, while courtesy in conversation and willingness to assist the customer were marked characteristics of all business houses of that "old school."

Of later growth was the firm of Dickinson Brothers & King, composed of William and John Dickinson, of Chicago, and Jerome A. King, the latter trained in James Brand's office. This firm, of whom some are still engaged in the manufacture of portland cement and plaster in this country, was an active business concern for many years, and marked the combining of the importing interests in the two great centers of cement distribution, namely, New York and Chicago. William Dickinson's cheery greetings, his friendliness and business acumen made friends for him everywhere; while King, with his long apprenticeship in importation, was most successful at his end of the line.

William Dickinson was actively interested in the sale of the first portland cement used in the Middle West. His story follows and is most interesting with respect to other facts:

In 1873 I was working for the Empire Warehouse Company on Market Street, Chicago, doing a general warehousing business and also acting as agents of a line of steamboats plying between Montreal and Chicago.

In the summer of that year the Montreal managers of the steamboat line running weekly between Montreal and Chicago, for which we were the Chicago agents, advised us that the boat leaving there being light of cargo, they had purchased for the account of the steamer 250 barrels of portland cement which they wanted us to sell on arrival. There had never been any portland cement in the West up to that date. After canvassing the situation, we were unable to get anybody to purchase it. Later on we called on John V. Farwell, of John V. Farwell Company, wholesale dry goods, and he stated that he had just returned from England where he had seen portland cement used in large quantities and knew all about it. As he intended soon to erect a building in which he would like to use some cement, he was very glad to purchase it. This was the first cement used in the Middle West. Subsequent shipments were received and met with increasing demand. The first sale in a country town was to John Allen, of Rockford, Illinois. He purchased it on the guarantee that a sidewalk laid with it in September would be in good condition in the following spring. If so, then to be paid for. Allen did a good piece of work, the sidewalk was a success, and led to other sales in that city.

Thus, with a very small beginning, trade gained rapidly year by year. The concrete conduits for cable car lines in the large cities began to consume thousands of barrels in their construction, and there were dealers in various parts of the West who gradually began to purchase portland cement of us. Notable among them were Cutler & Gilbert, Duluth; L. J. Pettit, Milwaukee; Saunders & Matthews, St. Paul; Thorne & Hunkins, St. Louis; C. A. Brockett, Kansas City; the Sunderland Brothers, Omaha; McPhee & McGinnity, and Hallock & Howard, of Denver.

In 1890 to 1892, importations of foreign cement into the United States had reached a maximum of about 3,000,000 barrels a year. The arrangements for importations of cement were the same as in many other articles. The freight room had to be engaged at the beginning of the year for monthly shipments of given quantities through the year, and cement purchased to fill the space was contracted for at the same time. This made the business quite complicated as supplies had to arrive at regular intervals in order to make the business anything like permanent. All contracts had to be based upon the regular delivery of the material, and thus the non-arrival of ships at stated periods caused great difficulty in keeping contracts supplied.

Inland Transportation Had Its Difficulties

Cement, as is well known, is a heavy article, and as it was sold at reasonably low figures it can readily be understood that in those early days the transportation of portland cement cargoes to the various points throughout the country was a serious matter. Railroad rates from the coast to the Ohio and Mississippi Rivers and the Central West were high and the object of the importer was to get his cement into New York in the summer season so that he would be able to avail himself of canal transportation to western markets at low rates. This necessitated the closest management in directing imports, and the greatest cooperation between the importer and the canal and lake lines of transportation. Railroad wars were also prone to exist prior to the days of "gentlemen's agreements" and Interstate Commerce control. It was a well-known fact that many railroads, in order to get this heavy body of freight, would cut rates and make figures based upon through transportation across the Atlantic, in order to secure an advantage over competing railroads. Salesmen representing the importers would go through the central and far West offering their materials "to arrive" to the large jobbers and distributors of cement in the great cities.

Salesmanship of this type was a friendly relation. The salesman would sometimes spend several days with his prospective customer in order to effect a sale and the bonds formed between the importer and his distributor were difficult to disturb and were usually lasting. Facilities had to be provided with these great distributors to take up large stocks of cement which might come in at untimely periods, and which had to be stored and carried. These were in some cases necessary at the lake steamship terminals. Banking facilities had to be provided to finance the importers and pay the freight on materials casually arriving from time to time in sailing vessels. The whole business was one requiring concentrated personal attention. It also established close friendships between importers and distributors, and led to the upbuilding of an enviable reputation all over the country for various brands of foreign portland cement. Such a reputation with successful merchandising, accompanied by the conservatism of the great engineers,

built up for the high-grade English, Belgian, German and French cements, proved most difficult to assail when the manufacture of portland cement began in the United States.

The first use of this foreign material, as already stated, was largely in sidewalks, a new use in this country, but one in which bad material would rapidly show itself, whereas good material not only added to the attractiveness of the work but made permanent the improvement under way.

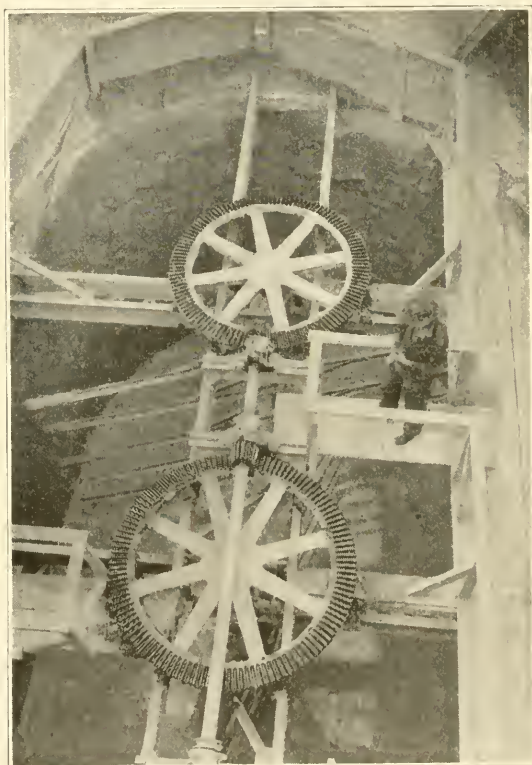
Superior Merit of Portland Cement Begins to Attract Attention

Specifications for massive foundations for important bridges and buildings began to call for portland cement. Construction in winter, where

portland cement stood the hardships of weather better than natural cement, was another field where engineers demanded the foreign article. In all construction the reputation of the engineer was at stake in the use of this higher-priced material, especially in cases of greater risk.

Owing to the difficulty of overcoming the early preference for foreign portland cement, the first manufacturers of the domestic product learned to look upon the United States as a large importer of cement and the market almost exclusively confined to the foreign brands.

This production of the late eighties was running somewhere about 100,000 barrels a year.



In "wet process" plants, water is added at the time of the first grinding operation. When this mixture, or "slurry," is fed to the kilns, it has the consistency of thick soup.

The fact that Johnson & Wilson, who were selling Saylor's Cement and were clever merchants in their difficult field, and Lesley & Trinkle, who were first distributors of Saylor's Cement in Philadelphia, and later gen-

eral agents for Giant Cement, had a hard time to make an impression upon the market, disclosed a situation practically controlled by the foreign cements.

There was a Builders' Exchange in New York where the dealers from New York and the adjacent territory assembled daily. In this market the representatives of the American cements just mentioned had to fight their way to get orders. New York was essentially a market for the foreign portland because it was there with the minimum of freight; but in western markets the American product began slowly to make its way because of slight advantages in price. New York was in most cases a closed book, so much so that Robert W. Lesley, in seeking to bring his American cement in competition with the successful importers who met him on the Exchange, soon acquired the title of "Crazy Lesley" by which name he passed on the Exchange until in later days the "arrival" of the American Portland Cement Industry enabled him to remove the adjective from his name.

To sum up the history of the importations, and the difficulties connected therewith, Mr. Weiler, previously mentioned, said:

No longer do we have to hire experts to watch our Custom-House clearances at New York or Baltimore or New Orleans and get all razzle-dazzled with ocean freights and customs duties and laws of "general averages" and when an ocean-boat is lost at sea, not only lose our cement, but have to chip in and help pay for the boat:

Whereat, in a fierce voice, I praise God that the days of imported portland cements have gone glimmering, and that the sales agents problems in handling cement now are insignificant compared to the tough old days that we have all outlived!

All hail! American portland cements! All brands, all mills, everywhere, in the best country on earth!

CHAPTER V

THE PORTLAND CEMENT INDUSTRY IN THE UNITED STATES

How the reputation of portland cement in Europe was first established through its use by the London Sewerage Department reached and impressed America, was described in the preceding chapter. As far back as 1865 portland cement was imported into this country and was used in a limited way for sidewalks and for the more difficult types of engineering work. Imports were small and there being but little knowledge of it, prices were high and the business limited. Rapidly, however, attention was called to the material by the steady growth of imports and its general adaptability to American engineering requirements. American ingenuity, always ready to seek new outlets for its labor and capital, naturally soon began studying the manufacture of portland cement.

Pioneers in the Portland Cement Industry in the United States

The history of an industry very properly begins with some account of its founder or founders. In the compilation of data covering the portland cement industry in the United States, the author finds himself somewhat in the position of the historians of the British industry who essayed to determine the identity of the man who first manufactured portland cement.

Among the pioneer manufacturers of portland cement in this country were David O. Saylor, Allentown, Pennsylvania; Thomas Millen, South Bend, Indiana, and John K. Shinn, Wampum, Pennsylvania.

David O. Saylor the First Successful Manufacturer

In the chapter on natural cements, a description was given of the early development of the natural cement industry in the Lehigh Valley, and of the men who had to do therewith. Of these David O. Saylor was referred to as a leader. In dealing with the pioneers of the portland cement industry in the United States, Saylor again becomes prominent as the first and foremost in this field. He was a farm boy, who came into Allentown from the neighboring countryside. He began business in a small way and ultimately, in connection with Rehrig and Woolever, purchased property on the Lehigh River above Coplay station on the Lehigh Valley Railroad, where he started the manufacture of natural cement, known commercially as "Anchor Brand."

Saylor's Early Experimentation

As one of the men who developed this business, it was but natural that the same imagination, courage and determination that brought successful development of these experiments into practical results should go on seeking further and wider fields. After several years of work in the small mill first built, Saylor, who had become familiar with the imported portland cement, was convinced that he could manufacture a similar article. His first idea was that he could take the natural rocks of the Lehigh district, burn them at high temperatures to incipient vitrification and by grinding the product make portland cement. The particular characteristics of the Lehigh rocks, which were high in lime, low in magnesia, and low in iron, made this almost possible. The rocks were laminated and not crystalline like the other natural cement rocks found in many other parts of the United States. They were, as stated, low in magnesia and iron content and in some of the layers did nearly approach the composition of the English and German portland cements in the condition in which the "slurry," or raw mix, was put into the kilns for calcination.

The first results of the work in the field mentioned justified Saylor's expectations. The rock did clinker, the burned product did resemble portland cement clinker, and when ground and made into briquettes gave results on the testing machine almost equal to the best imported brands. He naturally thought that he had solved the problem, and in 1871 applied for a patent which is as follows:

Saylor's Patent

UNITED STATES PATENT OFFICE

David O. Saylor, of Allentown, Pennsylvania.

Improvement in the Manufacture of Cement.

Specification forming part of Letters Patent No. 119,413, dated September 26, 1871.

To All Whom It May Concern:

Be it known that I, David O. Saylor, of Allentown, in the County of Lehigh, State of Pennsylvania, have invented a new and improved cement; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to make and use the same.

I have discovered that some kinds of the argillo-magnesian and also argillo-calcareous limestone found along the Appalachian range, containing more or less carbonate of lime, magnesia, silica, alumina, iron, salts, and alkalies adapted to the purpose, and which are now extensively used in the manufacturing of hydraulic cement, will make, when burned to a state of incipient vitrification, so as to be agglutinated, warped, or cracked, by contraction, and some burned to cinders, a very superior and heavy hydraulic cement, weighing from one hundred and ten pounds to one hundred and twenty pounds per bushel, and in every respect equal to the portland cement made in England and imported into this country.

The ordinary cement now in our market such as Rosendale, Coplay, and other American brands, are burned with the least possible degree of heat. The stage of calcination is arrested before it fuses or is contracted; should any of it do so it is thrown away as worthless. This cement weighs seventy to ninety pounds per bushel. I propose to burn this stone to the condition above indicated. After this calcination a selection is made and the pulverulent and scarified portions of the mass are picked out and thrown away. The remainder is then passed through a crusher; then through a mill consisting of ordinary sand, or buhrstone. The manufactured material is then placed in a layer of from two to three feet thick over the floor of a cool shed and left exposed to the air for about four weeks before it is fit to use.

The stone which I use for the purpose contains the same ingredients as the composition used for making portland cement, and the products cannot be distinguished from each other except by treatment.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. The process of making hydraulic cement from argillo-magnesian and argillo-calcareous limestone, substantially as herein specified and described.

2. As an improved article of manufacture, hydraulic cement produced from argillo-magnesian and argillo-calcareous limestone, substantially as herein specified and described.

DAVID O. SAYLOR.

Witnesses:

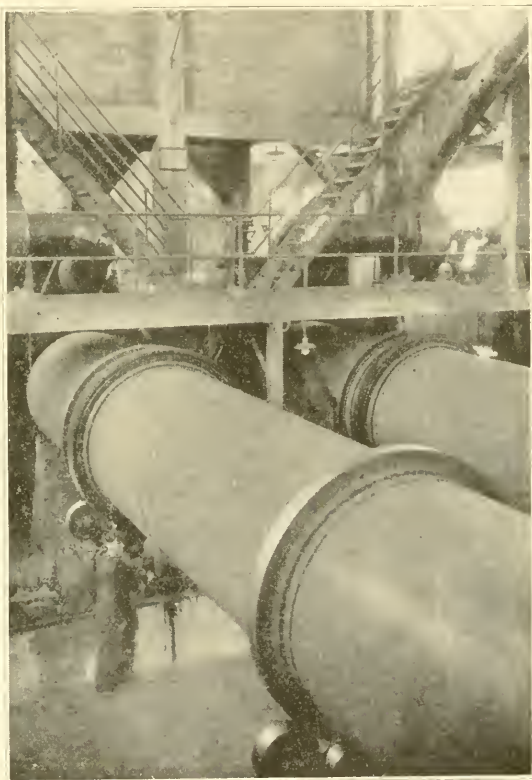
EDWIN ALBRIGHT

AUGUSTUS WEBER

It will be noted that in one paragraph he states that “the stone which I use for the purpose contains the same ingredients as the composition used for making portland cement, and the products cannot be distinguished from each other except by treatment.” This certainly was a progressive and far-reaching step in the pioneer days of the American portland cement industry. Saylor, full of vigor and energy, was constantly at the mill, always seeking to make more cement and cement of better quality. He manufactured a large quantity of his new product, but suddenly found that he was doomed to disappointment, for the material, owing to irregularities in the laminae of the rock, was not homogeneous and at long periods the briquettes, pats and works made with the cement all began to fail and disintegrate. At that time he had a large stock of this cement in his bins and was driven to his wits ends to know what to do with it. He put his brains to work, had analyses made of his rock, found that the analysis of his manufactured material was nearly that of the portland cement of commerce, and without anything but his native ability to guide him, experimented again by grinding the raw rock into powder, made the powder into brick, built vertical dome kilns upon designs he procured from England, following the type then in use on the Medway and Thames, burned the brick therein to clinker, and actually made portland cement.

Pennsylvania Geological Survey Investigates Lehigh District Cement Making Materials

At about that time the Pennsylvania Geological Survey had made a number of examinations into the limestones of the Lehigh District to determine their quality for use in iron making in connection with the rich hematite iron ore of the Ironton region, just back of the Lehigh River at Hokendauqua and Coplay. While the geological surveys were made by the engineer of the state, the analyses were made at Lehigh University by John W. Eckert, then a student at that college. Immediately after his graduation Mr. Eckert was selected by Mr. Saylor as his chemist and assistant in the operating of the Coplay Cement Company. Eckert, a typical Lehigh County youngster, full of resources and ability, was a most valuable assistant to Saylor in his work, furnishing the technical knowledge that Saylor's manufacturing experience required. He had also marked executive ability. It is believed that his employment as a chemist was the first step in scientific progress in the portland cement industry in the United



In "dry process" plants, moisture in the raw material is evaporated in rotary dryers.

States. After Eckert entered the employ of the company he came to look at the bins of damaged cement which Saylor then had on hand. Taking lumps of the material, which had by this time hardened in the bins, he suggested that the material, originally in the form of powder and now homogeneous and uniform, could, by burning it a second time to clinker, be ground and made available. The result was that the entire contents of the bins were ground and burned in the way suggested, with excellent portland cement as the result.

The combined efforts of these two men were very important to the industry in its early days, as the chemical knowledge of Eckert threw new light upon the material in the quarry and enabled the composition to be kept regular and uniform, with the result that the manufactured product was portland cement of the best quality.

In the sale of the Coplay Company cements, Saylor had associated with him the firm of Johnson & Wilson, of New York, who have already been mentioned, and who made successful progress in the introduction of American portland cement. Saylor was also associated with the firm of Lesley & Trinkle, of Philadelphia, of which Robert W. Lesley was a member, and which likewise was most energetic in the development and sale of the natural and portland cements made by the Coplay Company. John W. Trinkle of this firm was popular with all the large contractors and a most successful salesman.

Growth of Saylor's Cement Business

Under the name of "Saylor's Portland Cement" the material described by the foregoing patent found a sale all over the United States on engineering work of the largest kind, and received an award at the Centennial Exhibition, in Philadelphia in 1876. In December of the same year General Gillmore, then of the U. S. Engineer's Office, New York, recommended Saylor's portland cement as entirely trustworthy, and in 1878 the government specified it for the Eads jetties at the mouth of the Mississippi. Some years after the jetties were completed Major Eads spoke of it as portland cement of the best quality.

Through the firm of Lesley & Trinkle, which in 1874 began the shipment of natural cement in bulk to tidewater from the Cumberland cement works, the Coplay Cement Company was induced to do the same thing with its natural and portland cements; and for many years both Johnson & Wilson and Lesley & Trinkle had large packing houses in Jersey City and Philadelphia respectively, to which the cement was brought in bulk from the mills and there repacked in second-hand barrels which had come from the Rosendale and other mills shipping by water and which, therefore, had no means of getting the barrels back. These barrels, then a waste product, were bought up at low prices, and in times of shortage were supplemented by second-hand barrels from other sources available in the two cities.

The Coplay Cement Company was a close and compact organization composed of Saylor, Rehrig and Woolever, the owners, with Balliet, formerly a cashier in a bank in Allentown, as treasurer, and Eckert as superintendent. With the two firms of sales agents, they were quick to realize the importance of the industry that had been started, and for a number of years conducted without much competition a very successful and pros-

perous business, which played an important part in the development of the industry in this country.

Thus early records appear to substantiate the claim that Saylor was the first American manufacturer to patent and produce on a commercial scale a product corresponding to the imported portland cement.

How Millen Began

In 1871, Thomas Millen and his two sons were engaged in the manufacture of cement sewer pipe, artificial stone, sidewalks, etc., at South Bend, Indiana. How they became interested in portland cement was the subject of an entertaining after-dinner address delivered by Duane Millen, one of the sons, at a meeting of the Portland Cement Association in Atlantic City in 1906.

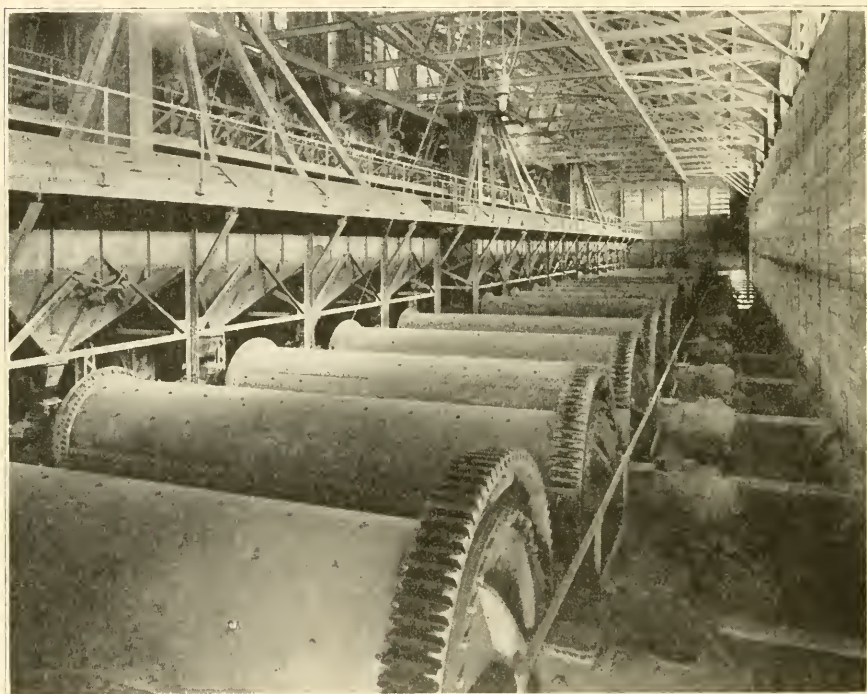
The first car of portland cement brought into South Bend by the Millens cost them \$9.12 a barrel. They often talked about portland cement but could not find out how it was made. One day, while Duane Millen was sitting in the office, a man entered and apologized for the intrusion by stating that he had seen something in the yard which made him think of home. He explained that it was a pile of empty cement barrels with the old K. B. & S. (Knight, Bevan & Sturge English cement) labels on them. He went on to say that he had worked for this company all his life and to see the old barrels was like meeting someone from home. He asked Mr. Millen why he did not make his own cement, adding that he had seen plenty of marl near South Bend. The marl around the lakes at Notre Dame and the blue clay in the river bed were the materials to use, he said, but he could not tell how to use them, having worked continuously in a single department in the English plant. He had heard of a book describing the process of manufacturing portland cement, but did not know where it could be obtained. Finally the Millens located the book through a Philadelphia house, which obtained it for them at a cost of \$14. After studying the book the elder Millen would go out to Notre Dame Lakes and bring back two pails of marl in his buggy, and a pail of blue clay from the St. Joseph River. They were taken to the cement pipe shop where his son Duane would mix them with his hands and burn the mixture in a piece of sewer pipe. After burning the mixture, the clinker in the pipe, when any could be found, was ground in a coffee mill.

After six months of experiment and research the Millens felt that they knew all there was to know about making portland cement; so they leased an old sawmill and built a kiln believed to be large enough to meet the entire cement requirements of the United States. It was 12 feet high by 4 feet in diameter. They continued building kilns each year until they had four, each 24 by 6 feet. In a few years demand far exceeded supply.

the War Department alone taking virtually the entire output. Yearly contracts were made with the government for all the cement manufactured.

In 1886, Duane Millen built works at Warner, New York, later known as the Empire Portland Cement Works, which was operated in conjunction with the old South Bend plant. In 1891, the Millens sold both plants and two years later engaged in manufacture at Wayland, New York.

Thomas Millen, who was born at Camillus, New York, died at his home in Syracuse on January 27, 1907, aged 75 years. Prior to going to



A battery of rotating steel cylinders loaded with steel balls do much of the fine grinding in modern cement plants. These grinders have superseded the millstones used in the early days.

South Bend, Indiana, where he began the manufacture of portland cement as described, Mr. Millen was a member of the firm of M. G. Field & Company, which conducted a stone and sewer pipe plant in Syracuse.

The ruins of the old Millen kilns as they appear on page 9 show the primitive character of these initial undertakings when compared with the modern cement plant. Their crumbling walls with grass-grown approaches have passed into the realm of things historic, but insofar as the requirements of that early period were concerned, they were quite as important as the cement mill of today.

The Work of John K. Shinn

Another important early portland cement plant was that erected about 1875 by John K. Shinn, at Wampum, Pennsylvania. Some have claimed that it was in this plant the manufacture of American portland cement first took place.

Before the manufacture of portland cement began at Wampum, the Wampum Mining & Manufacturing Company was in operation there. John K. Shinn was secretary and treasurer of the company, which was succeeded by the National Cement Company and later by the Crescent Portland Cement Company. After years of experiment, Mr. Shinn began, in 1874, to manufacture portland cement, but without entire success. Sometimes a good product would be produced and at other times failure would result. He advertised for an experienced cement maker and finally employed William Pucall, of Cincinnati. Mr. Pucall worked earnestly, putting in days and nights at a stretch. He erected a kiln, or furnace, with which he succeeded in obtaining a portland cement of uniform quality. It was exhibited at the Centennial Exhibition held in Philadelphia in 1876, and the firm was awarded a gold medal by the United States Centennial Commission. Associated with Mr. Shinn at the time were W. P. Shinn, president of the company, and Joseph Shinn, superintendent.

In the beginning many difficulties were encountered and the methods employed were very primitive. For example, in the reduction of clinker a groove conforming to the outline of a box was cut in a flat rock and into this was fitted the box in which the burnt clinker was placed and pounded, or pulverized. This was done by means of a heavy ear axle with the end stove up, the axle suspended from a spring pole such as is used in drilling small wells. This crude process preceded the use of modern mills. Having no apparatus for crushing or grinding limestone, a carload of material would be sent to Leetonia, Ohio, where it would be crushed and sent back to Newport, near Wampum, and taken to a sawmill in which the owner had rigged up a set of chopping buhrs. The limestone was run through these buhrs and ground as fine as possible, and then brought down to Wampum.

Under Mr. Shinn's plans, Mr. Pucall built a square kiln of fire brick, six or seven feet outside measurement and about eight feet high, the walls about a foot thick. The chimney was at one side of the top and a firebox was placed at the bottom of the kiln. The lime was mixed in certain proportions with a blue clay found nearby. The clay and limestone, finely ground, were mixed together wet. This mixture was shaped in fire brick molds, the material being taken to a brick yard for that purpose, where the bricks were dried on a hot floor. They were then brought back and placed in the kiln with alternate layers of coke, and burned. After burn-

ing, the brick were shipped to Cunningham's foundry in Newcastle, Pennsylvania, where they were ground on a set of buhr stones.

On November 1, 1878, Mr. Shinn, whose residence was given as Newcastle, Lawrence County, Pennsylvania, took out a patent on an improved method of burning lime and cement by means of a mechanical device designed to inject a forced draft into the lower part of the kiln. In the first or burning stage, combustion was promoted thereby and later cooling of the kiln contents expedited.

The Old Alamo Works

Texas was among the pioneer states in portland cement manufacture, the first plant established there being the Alamo Portland and Roman Cement

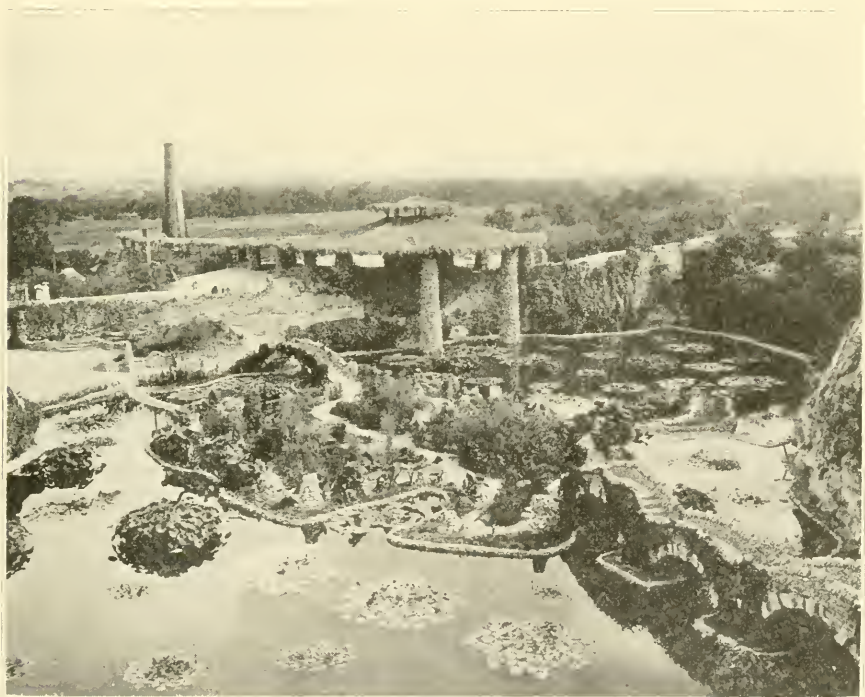


Original kilns used by the Alamo Cement Company, San Antonio, Texas, now a Mexican Village in Brackenridge Park in that city.

Company's works at San Antonio. The following interesting history of this company was contributed by C. Baumberger, president of the San Antonio Portland Cement Company:

In 1879 William Loyd, an Englishman who had had some experience in cement making in his native country, was hunting in the northern limits of San Antonio when he came across the rock quarries belonging to the city. There he found a blue argilla-

ceous limestone which he believed was cement rock. At the suggestion of W. C. Peters, engineer, and one of the proprietors of the Alamo Ice Company, a specimen of the rock was submitted to George H. Kalteyer, who had been an assistant in the laboratory of Dr. Frisenius, of Wiesbaden, Germany, the latter having been employed in the late sixties to investigate cements for the German government. Mr. Kalteyer made an analysis of the rock and pronounced it natural cement rock, containing about the correct proportions of lime and clay to make a true portland cement. Thereupon Mr. Loyd and W. R. Freeman, a hydraulic engineer and designer of several waterworks in Texas, conducted experiments in the way of burning. With the financial and technical assistance of Mr. Kalteyer they organized a company for the manufacture of hydraulic cements, and on January 15, 1880, the Alamo Portland and Roman Cement Company was incorporated. The capital stock of the company was only \$3,100, divided into 124 shares with par value of \$25 per share. The city was forbidden by its charter to sell the quarries, so the company leased them for a period of five years. The original incor-



A municipal sunken garden and Japanese lily pond in Brackenridge Park, San Antonio, Texas, originally a quarry attached to a cement plant. From this quarry, in 1879, the first material was taken and manufactured into portland cement in this district. Note the chimney of the Schoefer kiln in the left background.

porators were William Loyd, George H. Kalteyer, B. J. Mauermann, F. V. Weise, and W. E. Jones; Messrs. Kalteyer, Mauermann and Loyd being elected president, secretary and superintendent, respectively.

The mill was a timber affair and quite small. The equipment consisted of a small Blake jaw crusher, a pair of rolls and a vertical French buhr mill. A small slide-valve

engine, whose fly-wheel had wooden spokes and a rim of cast iron, furnished the power. The plant had a capacity of about ten barrels per day, the company endeavoring to follow European practice by grinding to a fineness of 5 per cent residue on a No. 50 cloth. All the cement was bolted and the rejection from the bolt sent back to the buhr mill. Fuel was hauled to the mill and the finished product hauled back to the city, the plant being three miles from the nearest railroad. The mill was a three-story affair. Seasoning took place on the two upper floors, where the cement was spread in layers of six to nine inches. It was then stored in wooden bins on the first floor. Tests for soundness were pretty much as in this day, but nothing was known about the boiling test, the cold water test being used to determine soundness. The result was an occasional shipment of "green cement." The mill was adjacent to the county poor house and the promoters of the enterprise were encouraged by their friends with the suggestion that when they got through they "wouldn't have far to go."

Burning consisted of the customary practice of that day, namely, alternate layers of fuel and rock, coke being used as fuel. It required about a week to burn a kiln, production amounting to about 120 barrels of cement. The product was hand-picked. That portion which had clinkered was classed as portland cement and the balance was used for making natural cement, called Roman cement. Lime burning and the sale of building stone aided the company to a precarious existence. The business expanded, however, and at the close of 1881 extensions were made and another kiln was installed. The capital stock was increased to \$10,000 and the company charter amended to read Alamo Cement Company. When sales finally reached about a thousand barrels per year enthusiasm supplanted anxiety, the company feeling that it was among the largest cement producers of the world. For Roman cement the company received about \$18 per ton, and \$22.50 per ton for portland cement in bulk. The cement was packed in the "Stark A Seamless" cotton bags, for which an extra charge of twenty cents each was made, and in billing the cement the following printed slip was attached:

Sacks—Sacks containing cement will be charged for at . . . cents each, but if returned in good order inside of . . . days from date of invoice, at our office or works, free of expense, we will refund four-fifths of the price charged.

ALAMO CEMENT CO.

The kilns used for burning cement were also used for burning lime. Cement burning was an occasional operation, the sale of lime and building stone being the chief business of the company.

It was difficult to introduce the new product, and in self-defense the company went into sidewalk construction to show the utility of cement for this purpose. Newly-laid walks would be covered with planks, ostensibly for purposes of protection, which enabled the company to make secret inspections to determine the stability of their product. A proud day in the history of the company marked the receipt of a high testimonial from General Q. A. Gillmore concerning the good quality of Alamo cement. Matters progressed, and in 1889 the facilities of the plant were materially increased. Eventually a rotary kiln was purchased, powdered coal being used for fuel. In 1901, when oil was discovered in Texas, it was substituted for coal as fuel. By 1908 demand for cement had so increased that the old mill was inadequate to meet the situation, and finally the company was incorporated as the San Antonio Portland Cement Company, and erected a new plant of much larger capacity.

Mr. Kalteyer, who was so prominently identified with the early history of the company, was taken ill during a visit to Europe, and upon his return died under an operation, in Philadelphia, on August 4, 1897. Plans

for improvements acquired by him while abroad were carried out by Mr. Baumberger.

Mr. Baumberger entered the employ of the original company in 1880 as a bookkeeper, subsequently becoming manager, secretary, and, in 1897, president of the company.

The original quarries and factory site of the old Alamo Company have been converted by the city into public gardens, which now constitute one of the chief attractions of San Antonio.

In these days of restricted hours of labor and time-and-over-time perquisites, it is interesting in the way of personal reminiscence to state that Mr. Baumberger received as bookkeeper of the company a salary of \$10 per month. The office of the company was in a drug store, from the proprietors of which he received the additional munificent compensation of \$30 a month for keeping books. He also made collections and handled the cash, frequently covering afoot the three miles between the office and mill.

American Cement Company Among the Pioneers

Another pioneer Eastern plant was that of the American Improved Cements Company, later on the American Cement Company, with works at Egypt, Pennsylvania. Robert W. Lesley was one of the founders of this company. The story of his initiation into the mysteries of cement manufacture and the subsequent development of his company is told in his own words:

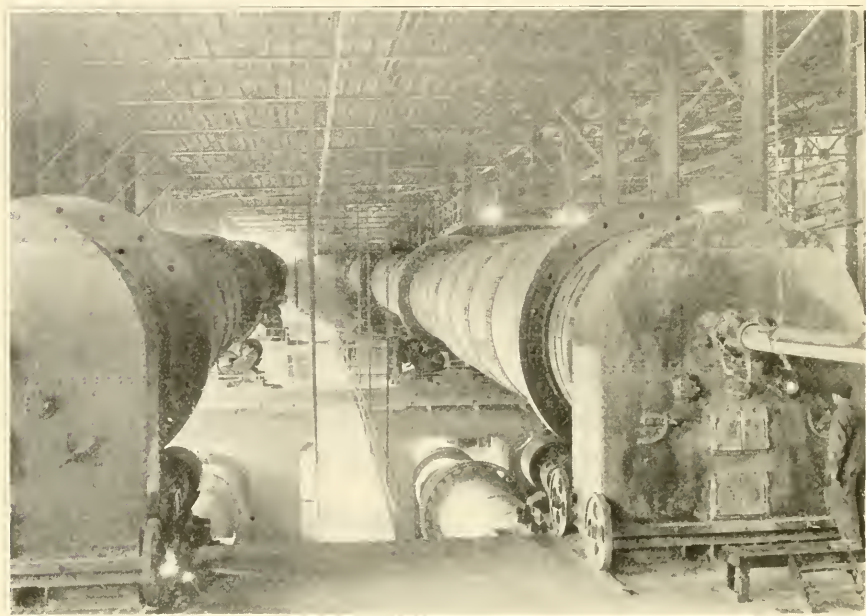
In 1874 John W. Trinkle and I were clerks in the advertising office of the Philadelphia Public Ledger. Among my duties was the collection of accounts from the stationers who sold the paper to their customers, and in that way I became quite familiar with "Stratena" and similar cements used for sticking together porcelain, wood, and like materials.

In the summer of that year my mother, Mrs. James Lesley, was visiting her brother, Dr. Thomson, near Cumberland, Maryland. She wrote me from there that my uncle had financial interests at stake in a Cumberland cement works threatened with failure, and asked whether I could sell some of their cement, which their Baltimore agent was unable to take on contracts he had made. With the courage of youth and the supposed knowledge I had of cement, I at once wrote her to send some on and I would take care of it.

Time passed, and a few weeks later I received a bill of lading from the Clyde Line of steamships advising me that 200 barrels of cement were on hand at their dock at the foot of Market Street and **had to be removed within twenty-four hours**, and that \$176 freight charges **must be paid that day**. This was a knock-out blow to my finances and to my idea of being a dealer in "sticky" cement. I went to the dock, looked at the 200 nice new barrels, and saw there more cement in a single minute than I have seen since in a career covering the sale of many millions of barrels.

Persuading the savings bank where I had my small capital to waive the ten-days' notice, I was able to pay the freight and through the assistance of a contractor, whose office rent I also collected, I was able to move the material to his yard on Broad Street, Philadelphia. These details having been disposed of, and having secured information

from the manufacturers as to what cement was and what it could be used for, I opened my heart to Trinkle, who was my senior in the office, and a confidant, and told him of my distress and trouble. Trinkle, who had a large vocabulary, promptly asked me: "What the hell is cement?" I replied that it was used for building. "Can it be used on bridges?" asked Trinkle. "Yes," I said. He then explained that a political friend of his had been instrumental in securing for a contractor the large bridge over the Schuylkill



Rotary kilns such as these are as long as a twenty-story building is tall and, in use, weigh as much as the Twentieth Century Limited. Below are the clinker coolers.

River at Callowhill Street, and he thought he could help us. I said: "All right, whatever we get you get half." A letter of introduction from the politician to the contractor enabled me to sell 10,000 barrels the second day we were in business, and the sale was due to the fact that we introduced a new method, that of bringing the cement in bulk from the mills and getting the contractor to give us back the empty barrels for nothing, which enabled us to sell under the price of Rosendale cement, brought down in barrels from the Hudson River.

Thus was formed the cement firm of Lesley & Trinkle, in which, with the modesty of youth, I made myself the senior partner.

We brought many thousands of barrels of cement from Cumberland on this and other contracts, but when the freights were advanced we had to seek other manufacturers and found a good and substantial friend and backer in Saylor, of the Coplay Cement Company, from whom we later bought many hundreds of thousands of barrels. Here, too, we employed the same method of handling cement, bringing it down in bulk to our packing house and putting it into second-hand barrels, and then delivering it on the job.

This connection led to our first experience with American portland cement, when we began to handle in a small way Saylor's portland, though before that time we had

received several shipments of foreign portland through James Brand, of New York. My recollection of those early days—and I am sure Trinkle's was the same—was that of two young men working about eight or nine hours a day for the Public Ledger and then working seven or eight hours a day more in the cement business, seeing customers by night, going to our packing house and storehouse, then at Front and Noble Streets, in the early morning, and then meeting again at lunch for a discussion of our business and its many problems.

Whenever opportunity offered I read Henry Reid's celebrated book on portland cement, which, fortunately, came to hand for review while I was on the Ledger staff. This great work was not only helpful but a stimulus to the novice, and I went through it again and again, acquiring a great deal of practical information and avoiding many mistakes in after years. Incidentally, this was the book that inspired Millen in his early efforts at South Bend, Indiana.

In those days our principal competitors were the great Philadelphia firms of Samuel H. French & Company, still active in the sale of cement, and J. Campbell Harris & Company, who had large plaster mills at Delaware and Fairmount Avenues. Our office was around the corner, at Front and Noble Streets, and we had many scraps with Mr. Harris over purchases and sales and over customers that we both sought.

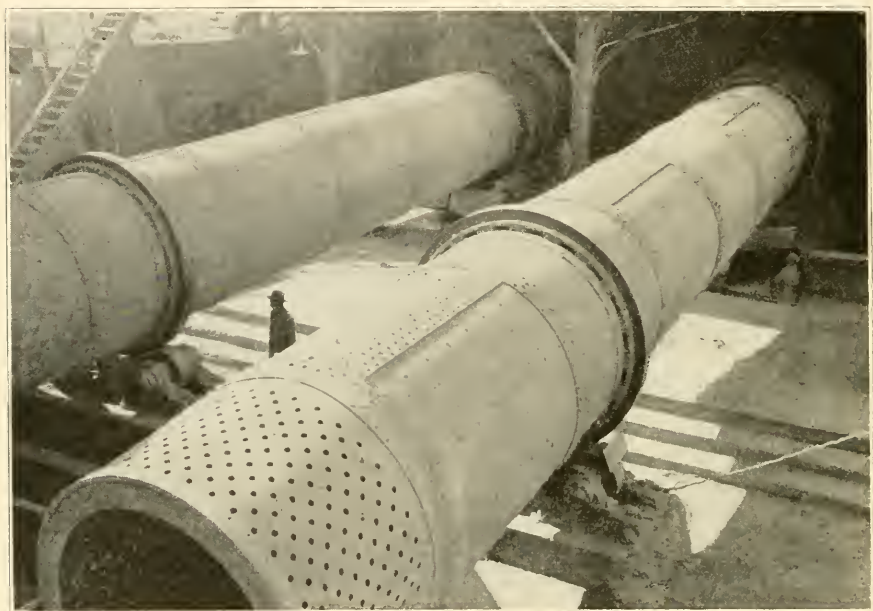
When J. Campbell Harris decided to go out of business in the early eighties, he sent for us and told us that he had selected us to go on with his business, then one of the largest in Philadelphia. We explained that we had no money, but he was set in his determination, and finally, on a shoestring deposit of a thousand-dollar government bond, we leased his property and purchased his stock, agreeing to pay for it as we took it and to maintain always the deposit of \$1,000 intact in his hands. The result of this was to give us a large standing in the trade and to supplement the good will that we had already earned among the contractors of Philadelphia and vicinity. Our natural cement trade increased largely, as we were thus enabled to store large quantities of Rosendale cement which arrived at the dock by water, and were enabled to broaden our importation of the foreign portland cement, which was then establishing a trade in this country.

About this time, through my association with government officers and contractors in Washington, I became acquainted with E. J. DeSmedt, who was then the inspector of asphalts and cements for the District of Columbia, and who was also running the Laboratory of the District, on 4½ Street, Washington. DeSmedt, a Belgian, was a scientist in asphalts and limestones, and a trained chemist. At that time I was connected with the Cumberland Portland Cement Company and became interested in some inventions that DeSmedt had worked out to make slow-setting natural cement at the Cumberland works.

Later on DeSmedt, who was familiar with tars and oils through his connection with the asphalt industry, invented a process for manufacturing portland cement whereby great economies were to be effected. The method of manufacturing in Europe was to take the mixture of clay and chalk and permit it to settle in backs or vats until, by evaporation and decantation, it became dry enough to handle. This material was then put around the stacks of the vertical intermittent kilns and permitted to dry, and finally was put in the kilns in layers with coal. Desire to avoid this expensive way of making cement and to save on the labor was the moving element in DeSmedt's invention. The great difficulty in all the American enterprises seemed to be getting the raw material into powder, then into paste, then into bricks or blocks, then putting it into the kiln, all with sufficient economy in view of the much higher cost of labor in this country than in Europe. Consequently, DeSmedt's patent, which was for the mixing of liquid hydrocarbons with the paste, was a step in advance. In this way a slurry was made which,

when compressed into balls or eggs, could at once be put into the kiln, dispensing with many of the intermittent steps of drying, thus saving much labor and money.

I made a number of experiments in a small kiln with the process above described, making the mixes with my own hands, manipulating the material to be made into briquettes until holes were burned in my fingers by the lime content, and finally succeeded in making what stood the test of portland cement.



After the white-hot clinker leaves the rotary kilns it is generally passed through smaller rotating cylinders to cool.

Following these experiments, which I thought had solved the problem, I got John W. Eckert, of the Coplay works, to test in a small 10-foot kiln, a charge of bricks made with liquid hydro-carbon, to determine the value of the process. The result was a failure, for instead of finding powdered clinker when we opened the kiln in the morning, we found that the bricks had squashed and softened and instead of cement clinker there was a mass of choked bricks and dust where the draft of the kiln had been unable to penetrate and proper burning had not been possible.

This led to an invention for making the material in a solid state whereby it could be handled easily and the proper draft in the kiln secured.

By the purchase of the Loiseau patents and the Loiseau press, which had been used in making artificial coal at the dock of the Reading Railroad in Philadelphia, a method was secured by which hard lumps of cement-making material mixed with liquid hydro-carbon in the shape of small eggs were manufactured at the rate of 100 tons a day and delivered automatically from the machine to the kiln. This apparatus was originally erected in a building in the back of the warehouses at Fairmount and Delaware Avenues, and all stone was brought down from the Coplay Plant and from other quarries in the Lehigh District. For many months the manufacture of portland cement was conducted by means of these eggettes, which were subsequently calcined in a small kiln and ground

to impalpable powder. This cement proved successful commercially, in a small way, and shortly thereafter it was determined to build a plant.

I started out on various explorations, both geographical and geological, going first up the Schuylkill Valley to Reading on foot with a well-known geologist, but found no available material with the proper economic possibilities. I walked over the region between Bedford and Cumberland, but turned it down on account of the geographic location with reference to markets. Finally I walked from Campbell Hall, New York, down the Delaware to Martins Creek, Pennsylvania. At that time there was no bridge and no railroad connection across the Delaware River, and going over in a small row boat, I started to walk from Martins Creek through Bangor, Bath, Nazareth and Northampton to the Lehigh River at Coplay, following the great belt of cement rock which stretched between the points described. My bottle of acid, my sample hammer, and my pack of samples were practically all the baggage I could carry.

I recollect distinctly that as my purpose was to secure a rock out of which we could make natural cement, then most largely in demand, and by adding lime to it to make portland cement, I did not take any rocks that had such a high lime content as to make great effervescence when acid was applied.

As a result of this trip I secured plans of many properties, options on some, and finally located at Egypt, on the line of the Iron-ton Railroad, upon rock which seemed to form the back door to the Coplay Cement Works, the front door of which was on the Lehigh River, above Coplay. As I look back I realize that my desire to secure material that would make both natural and portland cements led me to neglect the opportunity to make hundreds of thousands of dollars, for among the properties that were turned down because of high lime content were the great quarries now operated by the Alpha Portland Cement Company at Martins Creek, those at Bath, operated by the Bath Portland Cement Company, and those at Nazareth, operated by the Dexter Portland Cement Company.

In Philadelphia we had, as our superintendent, a stubby, fat, little Englishman, who claimed to have made cement in England at a place called Grimsby, and who was very vain and self-sufficient, making us all feel very ignorant when we talked to him, with his accumulated wisdom, though his experience carried no real scientific knowledge. With his assistance we erected a plant at Egypt, Pa., to make portland cement under the DeSmedt, Willcox, Lesley, and other patents. We erected our press roll with which we made the eggettes, ground the raw material on buhr stones, carried the eggettes by elevators up to the kiln, loaded the kiln with intermittent layers of coke and eggettes, and ground the clinker upon buhr stones again. The process was largely based upon a by-product, namely, coal tar and pitch, which were used as the liquid hydro-carbon and binder for the eggettes. The gas works of Philadelphia, then making gas with coal, permitted millions of gallons of this tar to go to waste each year, and it was possible to buy the material almost for the cost of barreling and loading it. The process was used by gas companies generally, but about that time the Lowe process of making water gas came into common use, being much more economical than the coal gas process, and we were left without our binder, and had to turn to the process then used at Saylor's works, which consisted of many acres of drying floors where the bricks cut from the paste were piled against heating pipes around the closed rooms in which the drying floors were situated.

It was not long after manufacture had started that winter came, and as the plant kept on running the stock sheets showed considerable portland cement on hand for delivery in the early spring, but when orders were sent up the cement was not forthcoming. Finally I went to the mill and demanded to see the bins where the portland cement was stated to be, and found that they were largely filled with natural cement

but veneered on the top and front with portland cement powder. When I asked the English superintendent where the portland cement was that he had reported on hand, his only answer was, "And did ye think I et it?" He was soon decapitated and John W. Eckert, then superintendent, reorganized the whole establishment, building new kilns and putting it all on a solid and substantial basis.

The original company which built the works was organized in 1883, and called the American Improved Cements Company, and my father-in-law, James M. Willecox, of Philadelphia, was the president. It was later on changed to the American Cement Company and is now the Giant Portland Cement Company.

An Early Oregon Plant

Among the early portland cement works with an interesting history was one established at Oregon City, Oregon, in 1884. According to early accounts the factory was designed and managed by a Mr. Middleton. He was regarded as something of a genius, for his plant was built along plans that did not come into general use, even in the older cement plants in the East, until ten years later.

C. A. Newhall, writing of this works in 1913, describes it as follows:

The raw material, a cement rock from southern Oregon, was ground in pebble mills and the raw mix burned in a gas-fired rotary kiln. The resulting clinker was ground to cement in a pebble mill. The gas was made for the most part from Australian coal, though local coal was used to some extent. Power was derived from the falls of the Willamette, just above the plant. The output of this pioneer plant was over 100 barrels per day of true portland cement. The product was in great demand and was superior in quality to the imported portland cement. It was used in sidewalks and curb work and in making artificial stone.

The plant was operated on this scale for a little over a year when it was decided to raise the capitalization of \$50,000 and increase the capacity of the plant. But about this time the directors ordered a survey of the quarry, which showed that the rock was practically exhausted. They had been operating on a thin, saucer-like body of stone standing on edge against the hill. The apparently inexhaustible mountain of stone was merely a thin veneer, so about 1890 the machinery was broken up and sold.

The First Michigan Mill

The Eagle Portland Cement Company was the first to operate in the Michigan field, which later became a great cement manufacturing district. The Eagle works were established at Kalamazoo in 1885. Some authorities fix the beginning of manufacture at this plant as early as 1872, a year after Saylor obtained his patent for portland cement, but William Dickinson, who is familiar with the history of the company, states that the first date, 1885, is correct. The founders of the plant included George L. Dunlap, Perry H. Smith, T. B. Blackstone, W. H. Schimpferman and Samuel Keith, of Chicago, and Frederick Bush, of Kalamazoo. According to Mr. Dickinson, marl and clay were obtained about two miles north of Kalamazoo. The materials were mixed in a pug mill and formed into bricks,

which were burned with alternate layers of coke. Two days were required for burning and a like time for the cooling of the kiln and contents. About a third of the product, and sometimes more, was too lightly burned to make good cement, thus curtailing output, but such as was properly burned made cement of good quality, which found ready sale at about \$5 per barrel. At the first annual meeting of the company the superintendent reported considerable cement on hand and all bills paid, so that the company considered it a conservative step to declare a ten per cent dividend. It transpired, however, that the stock on hand was much smaller than reported and that cost of manufacture had exceeded the price of the cement. The stockholders were disgusted as well as dumbfounded by these revelations and closed the mill, which soon thereafter was destroyed by fire.

Early Manufacture in New York

In the Rosendale district a number of men undertook to make portland cement out of Fullers earth and lime under patents of C. F. Dunderdale. Works were erected, but it was found the cost was so far out of proportion to the price that could be realized, that these works, which were established in 1876-77, were finally abandoned. So were other works subsequently established under the name of the Walkill Portland Cement Company, in the same district, and the National Cement Company, established by S. D. Coykendall.

"Buffalo Portland Cement" of which small quantities were manufactured from 1878 to 1885, resulted from the discoveries and patents of Uriah Cummings and L. J. Bennett, who were connected with these works, and who found by selecting the over-burned material from the common cement kilns of the Buffalo Cement Company, that a material resembling portland cement could be made. The rock, however, was largely magnesian, and for this reason no great quantities of portland cement were manufactured.

A New England Plant

The Cobb Lime Company, an important producer of lime at Rockland, Maine, started works in 1879 to produce portland cement, but owing to the high price of fuel the product was too costly for commercial success and this plant shut down after a short period of manufacture.

From the foregoing it may be seen that out of the several pioneer works started in this country from the time Saylor began, up to and including 1885, a large percentage were failures, and the situation did not offer a very encouraging outlook to the investor. At this period foreign portland cement had the market almost exclusively and there seemed little likelihood of growth for the American portland cement industry, the American

output in 1881 being approximately 60,000 barrels as compared with importations of about 221,000 barrels.

Development in the Lehigh District

The Lehigh district in Pennsylvania not only witnessed the founding of the industry, but soon became the great portland cement producing center of the United States. In 1890, the Lehigh mills produced 60 per cent of the total output of the United States. The percentage declined the three following years, reaching 44.9 per cent in 1893, when an upward trend began, culminating in the highest point in 1897, when the Lehigh district's share of the country's total output was 74.8 per cent. Thereafter a gradual decline set in, the percentage in 1923 being 25.9 per cent.

PORTLAND CEMENT PRODUCED IN THE LEHIGH DISTRICT AND IN THE UNITED STATES, 1890-1923

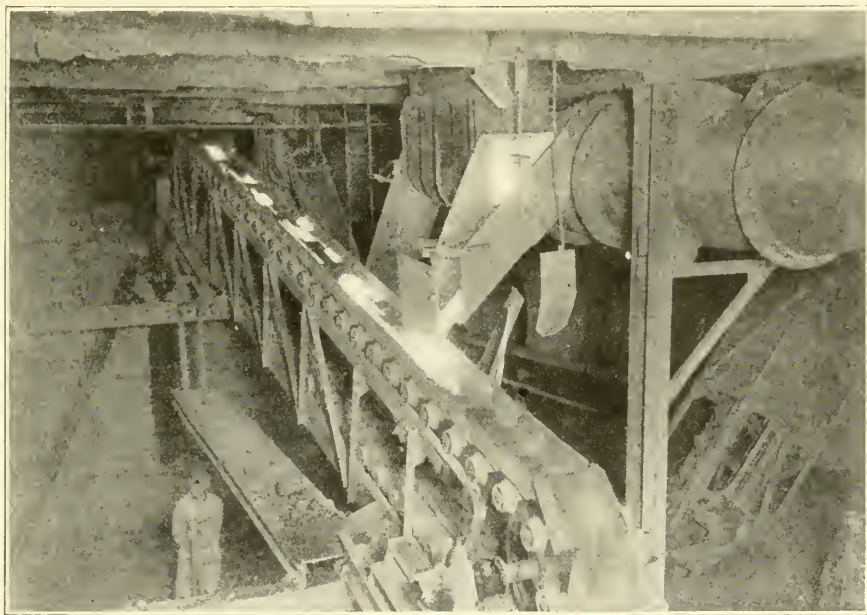
Year	Lehigh District (barrels)	United States (barrels)	Per- centage made in Lehigh District	Year	Lehigh District (barrels)	United States (barrels)	Per- centage made in Lehigh District
1890	201,000	335,500	60.0	1907	24,417,686	48,785,390	50.0
1891	248,500	454,813	54.7	1908	20,200,387	51,072,612	39.6
1892	280,840	547,440	51.3	1909	24,246,706	64,991,431	37.3
1893	265,317	590,652	44.9	1910	26,315,359	76,549,951	34.4
1894	485,329	798,757	60.8	1911	25,972,108	78,528,637	33.1
1895	634,276	990,324	64.0	1912	24,762,083	82,438,096	30.0
1896	1,048,154	1,543,023	68.1	1913	27,139,601	92,097,131	29.5
1897	2,002,059	2,677,775	74.8	1914	24,614,933	88,230,170	27.9
1898	2,674,304	3,692,284	72.4	1915	24,876,442	85,914,907	29.0
1899	4,110,132	5,652,266	72.7	1916	24,105,381	91,521,198	26.3
1900	6,153,629	8,482,020	72.6	1917	24,423,507	92,814,202	26.3
1901	8,595,340	12,711,225	67.7	1918	19,701,820	71,081,663	27.7
1902	10,829,922	17,230,644	62.8	1919	22,747,956	80,777,935	28.161
1903	12,324,922	22,342,973	55.2	1920	25,417,804	100,023,245	25.412
1904	14,211,039	26,505,881	53.7	1921	25,571,726	98,842,049	25.8
1905	17,368,687	35,246,812	49.3	1922	31,195,617	114,789,984	27.1
1906	22,784,613	46,463,424	49.0	1923	35,721,751	137,460,238	25.9

Thus in the early development of this great industry we find veritable romance, if romance ever attached to any phase of America's commercial and industrial progress. The country had its great captains of industry and finance when the Saylor, Millens and Shinn were experimenting. But they were concerned in railroads, iron, lumber and coal, or in the exploitation of land. Not one of them seemed to realize the great potential value of the work of the pioneers in the portland cement industry. The latter, like Fitch with his steamboat, labored in remote places with crude materials; and that one of the largest and most important industries in

the world, something calling for exact scientific procedure, should have been founded by men who, in some cases, had only hammers, cook stoves and coffee mills for experimental purposes, is one of the most remarkable and interesting of the many remarkable happenings in the industrial development of the United States.

The Increasing Ascendancy of Domestic Portland Cements

The competitors of the first American manufacturers of portland cement were the foreign portland cement makers and the American manufacturers of natural cements, whose products had the confidence of engi-



White-hot clinker dropping from the kilns onto the conveyor to the cooling cylinders.

neers and architects, and the further important advantage of familiarity in use. In 1871, the year Saylor took out his patent, the country was probably using at least 2,000,000 barrels of natural cement. Importations of portland cement must have been far below the American production of natural cement, as the first authoritative figures on imports recorded in 1878 show only 92,000 barrels. Therefore, it is safe to say that the first American manufacturers of portland cement had to overcome an established consumption of competing products amounting to more than 2,000,000 barrels, whose volume showed rapid expansion before the American works could get fully under way.

It may be well to present here statistics covering in concise form the history of the struggle for supremacy between American portland cement and its two competitors. The following table, which is confined to periods of five years, gives a sufficiently comprehensive survey of the field from 1878 to 1923. The first reliable statistics on portland cement production appeared in 1878.

PRODUCTION OF NATURAL AND PORTLAND CEMENTS IN THE UNITED STATES AND IMPORTATIONS OF PORTLAND CEMENT IN PERIODS OF FIVE YEARS FROM 1878 TO 1923 INCLUSIVE

Year	Natural Cement* (barrels)	Imported Portland** (barrels)	Domestic Portland (barrels)
1878	2,220,000 (Est.)	92,000	28,000
1883	4,100,000	456,418	90,000
1888	6,253,295	1,835,504	250,000
1893	7,411,815	2,674,149	590,652
1898	8,418,924	1,152,861	3,692,284
1903	7,030,271	2,251,969	22,342,973
1908	1,686,862	842,121	55,072,612
1913	744,658	85,470	92,097,131
1918	432,966	305	71,081,663
1923***		1,678,636	137,460,238

*The peak of production in natural cement occurred in 1899, when the output was 9,868,179 barrels.

**Importations of portland cement reached high-water mark in 1895, when 2,997,395 barrels were brought in. Figures given for the more recent years include all kinds of cement imported, but importations of cement other than portland are so small as to be practically a negligible factor.

***U. S. Geological Survey figures for 1923 include in one total "masonry, natural, and puzzolan cements." The total shipments are given as 1,271,674 barrels.

It will be seen from the foregoing table that while the importation and use of foreign portland cement was a serious obstacle at the very beginning of the portland cement industry in America, the actual consumption of all foreign brands seems absurdly small in the face of subsequent production by American mills.

As the history of the portland cement industry proceeds, it will be convenient to have for reference a compact but complete tabular statement covering the production of portland, natural and puzzolan cements from the time manufacture of each began in the United States. From this table full data may be readily obtained, and immediately following is a second table giving average factory prices of portland cement for the same period of time. In conjunction with these tables are two showing production of portland cement in 1922 and 1923 by states and by commercial districts.

The United States Geological Survey records covering the prices of portland cement group the years 1870 to 1880, inclusive, at \$3 per barrel for the average factory price. From that time up to and including 1923 the average factory prices per barrel in bulk were as follows:

AVERAGE FACTORY PRICE PER BARREL IN BULK OF PORTLAND CEMENT, 1870-1923

1870-1880.....	\$3.00	1897.....	\$1.61	1911.....	\$.844
1881.....	2.50	1898.....	1.62	1912.....	.813
1882.....	2.25	1899.....	1.43	1913.....	1.005
1883.....	2.15	1900.....	1.09	1914.....	.927
1884.....	2.10	1901.....	.99	1915.....	.860
1885-1888.....	1.95	1902.....	1.21	1916.....	1.103
1889.....	1.67	1903.....	1.24	1917.....	1.354
1890.....	2.09	1904.....	.88	1918.....	1.598
1891.....	2.13	1905.....	.94	1919.....	1.71
1892.....	2.11	1906.....	1.13	1920.....	2.02
1893.....	1.96	1907.....	1.11	1921.....	1.89
1894.....	1.73	1908.....	.85	1922.....	1.76
1895.....	1.60	1909.....	.813	1923.....	1.90
1896.....	1.57	1910.....	.891		

PORTLAND CEMENT PRODUCED IN THE UNITED STATES, 1922 AND 1923, BY STATES

State	Active Plants		Production Quantity (barrels)	
	1922	1923	1922	1923
Alabama.....	3	5	2,290,884	3,497,256
California.....	9	9	8,711,515	11,001,910
Illinois.....	4	4	6,407,129	7,147,906
Iowa.....	4	5	4,272,432	5,732,470
Kansas.....	7	7	4,634,287	6,025,657
Michigan.....	12	14	6,243,805	7,619,792
Missouri.....	5	5	6,170,633	7,305,997
New York.....	9	9	5,922,706	6,990,174
Ohio.....	5	6	2,835,243	4,188,755
Pennsylvania.....	22	22	33,276,093	38,157,482
Texas.....	5	5	3,628,756	4,178,895
Washington.....	4	4	1,942,781	2,105,711
Other States a.....	29	31	28,453,720	33,508,233
	118	126	114,789,984	137,460,238

a Colorado, Georgia, Indiana, Kentucky, Maryland, Minnesota, Montana, Nebraska, New Jersey, Oklahoma, Oregon, Tennessee, Utah, Virginia and West Virginia.

PORTLAND CEMENT PRODUCED IN THE UNITED STATES, 1922 AND 1923, BY DISTRICTS

Commercial District	Active Plants		Production Quantity (barrels)	
	1922	1923	1922	1923
Eastern Pennsylvania, New Jersey and Maryland.....	22	22	31,195,617	35,721,751
New York.....	9	9	5,922,706	6,990,174
Ohio, Western Pennsylvania and West Virginia.....	10	11	10,753,301	13,495,799
Michigan.....	12	14	6,243,805	7,619,792
Illinois, Indiana and Kentucky.....	10	10	17,998,914	21,193,666
Virginia, Tennessee, Alabama and Georgia.....	8	11	5,954,043	7,908,846
Eastern Missouri, Iowa and Minnesota.....	9	10	11,392,552	14,037,099
Western Missouri, Nebraska, Kansas and Oklahoma.....	11	11	8,025,720	9,779,034
Texas.....	5	5	3,628,756	4,178,895
Colorado and Utah.....	5	5	2,020,784	2,427,971
California.....	9	9	8,711,515	11,001,910
Oregon, Washington and Montana.....	8	9	2,942,271	3,105,301
	118	126	114,789,984	137,460,238

PRINCIPAL HYDRAULIC CEMENTS PRODUCED IN THE UNITED STATES, 1818-1923

Year	Natural Cement			Portland Cement			Puzzolan Cement			Total		
	Quantity (barrels)	Value		Quantity (barrels)	Value		Quantity (barrels)	Value		Quantity (barrels)	Value	
1818-1829	300,000	\$ 246,000								300,000	\$ 246,000	
1830-1839	1,000,000	850,000								1,000,000	850,000	
1840-1849	4,250,000	3,612,500								4,250,000	3,612,500	
1850-1859	11,000,000	9,350,000								11,000,000	9,350,000	
1860-1869	16,420,000	13,957,000								16,420,000	13,957,000	
1870-1879	22,000,000	18,700,000								22,000,000	18,700,000	
1880	2,030,943	1,726,707		82,000	\$ 246,000					2,072,943	1,852,707	
1881	2,440,000	2,379,000		42,000	126,000					2,500,000	2,529,000	
1882	3,165,000	3,481,500		85,000	191,250					3,250,000	3,672,750	
1883	4,100,000	4,100,000		90,000	193,500					4,190,000	4,293,500	
1884	3,900,000	3,510,000		100,000	210,000					4,000,000	3,720,000	
1885	4,000,000	3,200,000		150,000	292,500					4,150,000	3,492,500	
1886	4,350,000	3,697,500		150,000	292,500					4,500,000	3,990,000	
1887	6,692,744	5,186,877		250,000	487,500					6,942,744	5,674,377	
1888	6,253,295	4,533,639		250,000	487,500					6,503,295	5,021,139	
1889	6,531,876	4,702,951		300,000	500,000					6,831,876	5,202,951	
1890	7,441,116	3,822,501		335,500	704,050					7,776,616	4,526,551	
1891a	7,767,979	3,671,147		454,813	967,679					8,222,792	4,638,826	
1892	8,211,181	3,991,455		547,440	1,152,600					8,758,621	5,144,055	
1893	7,411,815	3,251,757		590,652	1,158,138					8,002,467	4,409,895	
1894	7,563,488	3,635,731		798,757	1,383,473					8,362,245	5,019,204	
1895	7,741,077	3,895,424		990,324	1,586,830					8,731,401	5,482,254	
1896	7,970,450	4,049,202		1,543,023	2,424,011		12,265	\$ 12,250		9,525,738	6,485,463	
1897	8,311,688	3,862,392		2,677,775	4,315,891		48,329	48,500		11,037,792	8,226,783	
1898	8,418,924	3,888,728		3,692,284	5,970,773		233,000	198,050		12,344,208	10,057,551	
1899	9,868,179	4,814,771		5,652,266	8,074,371		335,000	268,000		15,855,445	13,157,142	
1900	8,383,519	3,728,848		8,482,020	9,280,525		365,611	274,208		17,231,150	13,283,581	
1901	7,084,823	3,056,278		12,711,225	12,532,360		272,689	198,151		20,068,737	15,786,789	
1902	8,044,305	4,076,630		17,230,644	20,864,078		478,555	425,672		25,753,504	25,366,380	
1903	7,030,271	3,675,520		22,342,973	27,713,319		525,896	542,502		29,899,140	31,931,341	
1904	4,866,331	2,450,150		26,505,881	33,355,119		303,045	226,651		31,675,257	26,031,920	
1905	4,473,049	2,413,052		35,246,812	33,245,867		382,447	272,614		40,102,308	35,931,533	
1906	4,055,797	2,423,170		46,463,424	52,466,186		481,224	412,921		51,000,445	55,302,277	
1907	2,887,700	1,467,302		48,785,390	53,992,551		557,252	443,998		52,230,342	55,903,851	
1908	1,686,862	834,509		51,072,612	43,547,679		151,451	95,468		52,910,925	44,477,656	

PRINCIPAL HYDRAULIC CEMENTS PRODUCED IN THE UNITED STATES, 1818-1923.—Continued

Year	Natural Cement		Portland Cement		Puzzolan Cement		Total	
	Quantity (barrels)	Value	Quantity (barrels)	Value	Quantity (barrels)	Value	Quantity (barrels)	Value
1909	1,537,638	\$ 652,756	64,991,431	\$ 52,858,354	160,646	\$ 99,443	66,689,715	\$ 53,610,563
1910	1,139,239	483,006	76,549,951	68,205,800	95,951	63,286	77,785,141	68,752,092
1911	926,091	378,533	78,528,637	66,248,817	93,230	77,786	79,547,958	66,705,136
1912	821,231	367,222	82,438,096	67,016,928	91,864	77,363	83,351,191	67,461,513
1913	744,658	345,889	92,097,131	92,557,617	107,313	97,663	92,949,102	93,001,169
1914	751,285	351,370	88,230,170	81,789,368	68,311	63,358	89,049,766	82,204,096
1915	750,863	358,627	85,914,907	73,886,820	42,678	39,801	86,708,448	74,285,248
1916	842,137	430,874	91,521,198	100,947,881	c	c	92,363,335	101,378,755
1917	639,456	435,370	92,814,202	125,670,430	c	c	93,453,658	126,105,800
1918	432,966	401,341	71,081,663	113,730,661	c	c	71,514,629	114,132,002
1919	528,589	583,554	80,777,935	138,130,269	c	c	81,306,524	138,713,823
1920	767,481	1,150,890	100,023,245	202,046,955	c	c	100,790,726	203,197,845
1921	539,402	897,025	95,507,147	180,778,415	c	c	96,046,549	181,675,440
1922	889,428	1,293,598	117,701,216	207,170,430	c	c	118,590,644	208,464,028
1923	1,271,674	1,947,352	135,912,118	257,684,424	c	c	137,183,792	259,631,776
	b 240,234,550	b\$ 156,319,648	1,641,771,862	\$2,136,635,419	4,806,757	\$3,937,695	1,886,813,169	\$2,296,892,702

a The figures for 1800 and previous years are estimates made at the close of each year and are believed to be substantially correct. For years since 1890 the official figures are based on practically complete returns from all producers.

b Includes puzzolan cement.

c Included with natural cement.

Early American Made Portland Cement Often Sold Under Foreign Labels

The commercial introduction of American portland cement was no easy task for the pioneers in the industry. Prejudice against the American product in the early days was so uncompromising that some of the large distributors of foreign portland cement throughout the country actually insisted that American manufacturers should have the names of special



Great piles of clinker are held in reserve at most cement plants. Being impervious to the elements, it is stored until needed. Then it is ground, gypsum added, and sacked.

brands of English, German and Belgian portland cements placed on the barrels when shipped into some of the western and southern markets; however, this continued but a short time, for gradually the extraordinary quality and valuable characteristics of American portland cement made themselves felt in the markets of the country.

In a paper on the Manufacture of Cement delivered before the International Engineering Congress in 1904, Robert W. Lesley said:

The first portland cement made in America involved a great cost of labor and could not be offered at prices very much below the foreign article, and as the cement in a building costing a million dollars represented but a small percentage of the total cost of the structure, and the difference between the prices of foreign and domestic portland

cements being, in turn, but a very small percentage of the total cost of the cement, it was almost impossible to convince engineers and architects that American portland cement should be used. By slow degrees the prejudice in favor of the imported cement was overcome.

Importance of Patents Covering Early Processes

In seeking to improve methods of manufacture, each of the works established when the industry was just struggling for a footing was based upon patents of one type or another. It is almost axiomatic that while a patent does not give a man or an industry a right to exist, it does give a right to show a right to exist. This seems to have been exemplified in the portland cement industry, and the works that are shown to have survived the struggles of the early days are those whose founders and owners possessed initiative and sturdy intellectual attributes. While these qualities would intrinsically have made for success under ordinary conditions, in this case the inventors were, as stated, merely given the right to show their right to exist by patents, and they distinctly made good in the development of the industries placed in their hands.

It was not until 1890, or thereabouts, that any great progress was made in combating the paramount influence of the foreign portland cement in the American market. The figures of the United States Geological Survey appearing on a preceding page indicate the growth of the industry from 1880 to 1890, and show how slowly it progressed. The following complete table of imports covering the period named shows how firmly entrenched in the United States were the foreign manufacturers:

FOREIGN CEMENT IMPORTED FOR CONSUMPTION, 1878-1923, IN
BARRELS OF 380 POUNDS

1878	92,000	1893	2,674,149	1908	842,121
1879	106,000	1894	2,638,107	1909	433,888
1880	187,000	1895	2,997,395	1910	306,863
1881	221,000	1896	2,989,597	1911	164,670
1882	370,406	1897	2,090,924	1912	68,503
1883	456,418	1898	1,152,861	1913	85,470
1884	585,768	1899	2,108,388	1914	120,906
1885	554,396	1900	2,386,683	1915	42,218
1886	915,255	1901	939,330	1916	1,836
1887	1,514,095	1902	1,963,023	1917	2,323
1888	1,835,504	1903	2,251,969	1918	305
1889	1,740,356	1904	968,409	1919	8,931
1890	1,940,186	1905	896,845	1920	524,604
1891	2,988,313	1906	2,273,493	1921	122,322
1892	2,440,654	1907	2,033,438	1922	323,823
				1923	1,678,636
				Total	51,039,381

Concerning the status of the American portland cement industry in 1890-91, S. B. Newberry, in the United States Geological Survey report,

says there were 17 plants whose geographical distribution and annual production were as follows:

PORTLAND CEMENT WORKS AND PRODUCTION IN 1890-1891

District	No. of Works	1890		1891	
		Barrels	Value	Barrels	Value
California, San Diego.....	1	.....	.....	5,000	\$ 15,000
Colorado, Denver.....	1	12,500	\$ 40,000	12,500	40,000
Dakota, Yankton.....	1	.....	.....	31,813	71,579
Indiana, South Bend.....	1	15,000	36,000	15,000	36,000
New York, Onondaga County, Buffalo, etc.....	5	65,000	140,000	87,000	290,000
Ohio, Bellefontaine and Columbus...	2	22,000	49,000	35,000	82,000
Pennsylvania, Lehigh and Lawrence counties.....	6	221,000	439,050	268,500	532,850

CHAPTER VI

OTHER CEMENTS

The world's demand for mortars, especially mortars of higher strength, had constantly increased with the greater size of buildings and the necessity for larger, stronger bridges, aqueducts, dams, roads, and other engineering structures. It was but natural therefore that inventors and engineers should seek mortar-making materials other than the natural and portland cements then known and so generally used.

The results of this trend were several types of cements, some of which have been referred to briefly in a preceding chapter.

Puzzolan Cement

The first and most important of these cements was that described in all books on cement as "puzzolan" and "slag" cement. "Puzzolan" is a term applied to a compound of silica and alumina which, when mixed with slaked lime and made into mortar, has the property of hardening under water. There are several classes of material which have this quality, such as "trass," "tufa," "arenas," and the well-known "puzzuolana" found in the southern part of Italy.

"Slag" cement is, however, by far the most important of the puzzolan cements. It is the product obtained by mixing powdered slaked lime and finely pulverized blast furnace slag. In this material the hydraulic ingredients are not burned with the lime, but are present in the cement in a mechanical mixture only.

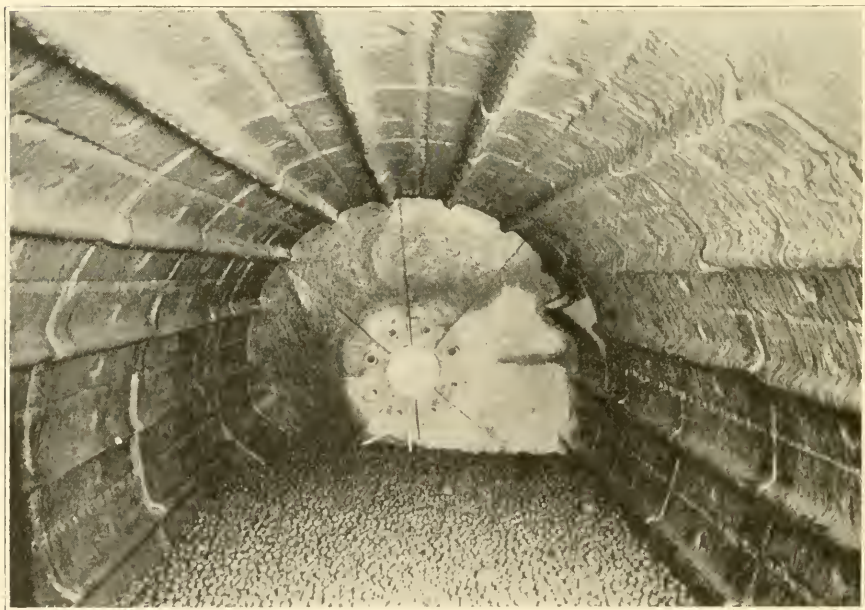
This cement originated in Germany and was manufactured in Westphalia as far back as 1863. The process employed was described by W. Lurmann before the Technical Society at Osnabruck in January, 1867. Many improvements on the original process were made by German inventors between 1863 and 1900, and owing to the desire of German iron manufacturers to find an outlet for their slag, the production of this cement became quite general in Germany. Large quantities were being made about 1885, but in a United States Consular Report dated July 3, 1895, it is stated that of about fifty slag cement works in Germany in 1890, only two were then in operation. The French writer Candlot, referring to this industry about 1900, states that no new works had been built in Switzerland, and that in Belgium but one remained, while in France there were but three.

On February 5, 1895, Jasper Whiting, of Chicago, Illinois, applied for a patent which was granted to him on August 20, 1895, the claims of which are as follows:

1. The method of manufacturing cement from slags which consists in chilling molten slag in water, drying and grinding the product, and adding thereto caustic soda or its equivalent in a dry state.
2. The method of manufacturing cement from slags which consists in chilling molten slag in water as it comes from the furnace, drying and grinding the slag, and adding thereto slaked lime and caustic soda both in a dry state and in the proportions substantially as set forth.
3. A cement composed of blast furnace or other slag in a dry pulverized form and caustic soda in a dry state, in substantially the proportions set forth.
4. A cement composed of blast furnace or other slag in a dry pulverized form and caustic soda and slaked lime in a dry state and substantially in the proportions set forth.

The general purpose of this invention as stated by him was that:

The presence of caustic soda renders the resulting cement much stronger and quicker setting and by varying its proportions a cement of any desired quality can be obtained.



Tons of steel balls in the interior of a tube mill pulverize the materials to a powder finer than flour.

Under this patent, which was the result of experiments conducted by Mr. Whiting for nearly two years, a plant for the manufacture of cement was established at the North Works of the Illinois Steel Company, in Chicago. Later this plant was greatly enlarged and the output increased. The

material was marketed under the name of "Steel Portland Cement," and was largely used for important works of all kinds throughout the South and West.

The Brier Hill Iron & Coal Company, of Youngstown, Ohio, took out a license under the Whiting process, and from 1898 to 1910 manufactured cement under the patent, calling it "Brier Hill Portland Cement."

Considerable discussion arose as to whether this particular cement properly came under the definition of "Portland Cement" and the manufacturers of the latter very naturally sought to exclude the "Steel Portland Cement" from works where portland cement or high-grade American portland cement was specified. Numerous cases of this kind occurred in Baltimore. In the letting of city contracts in 1900, the issue was raised, and again in the same year a government board of engineers was appointed to investigate the question of whether "Steel Portland Cement" could be accepted and used in the United States lock at Plaquemine, Louisiana, where high grade American portland cement was specifically required, as being within the meaning of the Government specification of February 16, 1898, for the construction of the Plaquemine Lock.

The investigation continued for some time, and the testimony and conclusions cited in the report of the engineers form an admirable summary of the status of puzzolan or slag cements. The conclusion of the report was that the cement sold by the Illinois Steel Company under the name of "Steel Portland Cement" should be classified under the generic name of puzzolana cement and under the specific name of slag cement and could not be classified as a portland cement.

As a historical fact, and possibly as a business fact, this adverse report was one of the most advantageous things that ever occurred to a great manufacturing concern such as the Illinois Steel Company, which about that time had become a part of the United States Steel Corporation. Undaunted and undismayed by this adverse decision, which to a less courageous set of men would have meant the end of a then successful business, E. J. Buffington, the president of the Illinois Steel Company, Edward M. Hagar, then general sales agent of the Cement Department, and others connected with that concern, and the United States Steel Corporation, immediately set about to make a true portland cement with the material produced from the steel works. Taking specially selected slags, they added to them limestone in the requisite amount to bring the content of the mixture, when calcined, to the proportion of normal portland cements as then required under existing specifications for that material, and by grinding this mixture to impalpable powder and putting it through rotary kilns, produced clinker similar to that produced under ordinary portland cement processes of manufacture which, when ground, made a true portland cement that for years has held its own in the market as one of highest quality.

Passow and Colloseus Cements

Under this general type, though made without admixture of lime, are the Passow and Colloseus cements, also mentioned in a previous chapter. Each of them has an American history, though brief.

The Passow patents were the result of studies of Dr. Passow, one of the leading scientists in Germany. The process was used in Germany in a number of works, and for a brief time the cement was manufactured on a very limited scale in this country.

The Colloseus patents were brought to this country by Vavasour Earle, of England, and Dr. Susskind, of Germany, who endeavored to enlist capital in the process. That they attached high value to their patents



Throughout the entire process of portland cement manufacture the materials are under the watchful eye of the chemist.

was shown during a dramatic meeting they had sought with the Board of Directors of the North American Portland Cement Company. Panic was thrown into the souls of the American manufacturers when Susskind, being asked what the price of the invention was, said: "A million!" One of the directors present asked: "A million dollars?" "No," Susskind replied, "a million pounds." Thereupon the Americans, in a fainting condition, retired for deliberation. The result was that a commission consisting of Dr. Clifford Richardson, the well-known chemist and scientist, and

Robert W. Lesley, cement manufacturer, was appointed to visit Europe and investigate the process. This they did, finally reporting against its practicability.

Subsequently William R. Warren and associates bought a small works in Buffalo and started manufacturing Colloseus cement, but without achieving very satisfactory results.

Iron Cement

This material was produced as specially adapted to salt water construction, and for a time small quantities were brought into the United States, but none was manufactured here. The invention was that of Dr. Michaelis, the distinguished German chemist, and the cement was manufactured by the Krupps at their great steel works in Essen.

Silica Sand Cement

In 1893, a patent was issued to Verner Frederik Lassoe Smidth, of Copenhagen, Denmark, for "a new and useful improvement in cement called 'Sand Cement'." The claim was as follows: "The improved cement herein described consists of a dry ground mixture of ordinary cement and sand, gravel, or other filling material, substantially as set forth." The object of the invention was stated to be to grind a filling material with the ordinary cements of commerce and to produce, when portland cement was used, a new kind of cement by which a mortar is obtained that has all the good properties of cement mortar but is just as cheap, if not cheaper than the ordinary lime mortars.

Mr. Smidth was the head of the well-known engineering firm of F. L. Smidth & Company, of Copenhagen, with offices throughout the world, and stood high in his profession. At his works in Malmö, Sweden, and also at the Aalborg Portland Cement Works in Denmark, many experiments were made with this material, and considerable quantities were produced. In many cases excellent results were shown in tests and great economy found, while in other cases the results were not so satisfactory, especially when very lean mixtures were made.

As early as 1893, Danish engineers came to this country to introduce the cement, and while, as above stated, varying results were obtained by those who tested it, no commercial success in the introduction of the process was made, and it was not until somewhere about 1905 or 1906, when a serious shortage of cement occurred in this country, that the manufacture of this cement began on Long Island, near New York, where the Standard Silica Cement Company established a works with quite an output.

Contemporaneously with this, Sears Humbert & Company, dealers in cement in Chicago, established a similar plant in that city under the title

of Calumet Cement Company. Neither of these plants achieved permanent success and ultimately the process was abandoned.

Blended Cement

Blended cement was somewhat like puzzolan and portland cements. It was used extensively in California during the construction of the Los Angeles Aqueduct. A volcanic tuff, known locally as "tufa" cement,



The portland cement industry is the fourth largest manufacturing consumer of coal, although oil and gas are used to some extent. An unfailing supply of fuel is absolutely essential to successful cement plant operation.

was ground with portland cement. In 1910 about 95,000 barrels were produced, the value being \$1.50 to \$1.60 per barrel. The output of this cement in 1912 reached a little over two hundred thousand barrels, valued at \$1.50 per barrel. •

CHAPTER VII

LEADING PIONEER COMPANIES IN PORTLAND CEMENT MANUFACTURE

As has been stated in mentioning those who were pioneers in the industry, D. O. Saylor's works at Coplay, operating under the name of the Coplay Cement Company, had achieved commercial success by 1890.

On the Ironton Railroad, back of Saylor's plant, was the American Cement Company, described by Robert W. Lesley in the story of his early connection with the industry.

Between Whitehall station on the Lehigh Valley Railroad, and Coplay station to the east of it, there was a high bluff of cement rock. The tracks of the Lehigh Valley Railroad ran along the property, and just beyond them was the Lehigh River. On the other side of the river, at Whitehall, was the Lehigh Coal & Navigation Company's canal.

Just as the American Cement Company, rather than make new experiments, had settled back of the Coplay works, using practically the same rock, so, too, this attractive bluff along the Lehigh could not remain long unused. Bonneville, already mentioned, was active in developing along this frontage, and at one time there were two mills, one at Whitehall, that of the United States Cement Company, in which S. B. Wellington was largely interested, and another immediately beyond Saylor's works, which was operated for a time and subsequently became the first plant of the Atlas Portland Cement Company, then known as the Keystone Company. All these works were in operation, making both natural and portland cement—much natural and little portland.

In the early days of all of them, and this is true also of the Keystone Company, the manager of each plant would go to his works in doubt as to whether he or the sheriff would be the first to take charge. Those were "parlous times" for all who had to do with manufacturing at that period.

The United States mill was subsequently bought, and became the Whitehall Company. The Bonneville Cement Company was also one of the early producers. The Keystone Cement Company, predecessor of the Atlas Portland Cement Company, started operations in 1889, and under the Navarros was the first concern to use the rotary kiln in the Lehigh district, initial experiments with the rotary kiln having taken place in the Rosendale district, New York, in 1886, as is described elsewhere by A. de Navarro. In 1892, according to F. H. Lewis, the Atlas Portland Cement

Company succeeded in burning portland cement clinker at Coplay in rotary kilns with crude oil, which then cost about a cent per gallon. Mr. Lewis says: "It burned cement clinker very readily; its calorific value was high, and it took only ten to twelve gallons of oil to burn a barrel of cement. At the time and under the prevailing conditions, it was a success. For the first time rotary kilns were functioning readily, and they made then, as they do now, an interesting and impressive spectacle of chemistry applied on a large scale to industrial uses."

Across the river from Whitehall, at Siegfried Bridge, was the old Allen mill which General Siegfried established for making natural cement for the Lehigh Canal locks; and nearby was an old paint mill using the red ores for making paint for iron construction and similar types of work. Later on the Allen mill was turned into a portland cement plant, and the Ackermans, of New York, who had been connected with the Rock Lock Cement Company, Lawrence, and other cement companies in the Rosendale region, established portland cement works in the old paint mill, and later on acquired the old Allen plant. Four generations of the Ackerman family have been in the cement business and representatives of the present generation are still successfully operating the large cement company at Siegfried Bridge, making the well-known "Dragon" portland cement.

Whenever David O. Saylor had occasion to go to New York over the Central Railroad of New Jersey or the Lehigh Valley Railroad, he noticed in the railroad cuts large bodies of rock similar to the rock he was using on the banks of the Lehigh River, near Coplay station. For many years he kept this knowledge to himself, and the property below Easton remained undeveloped, while Saylor and his associates were building up their business at Coplay. Others, however, friends and associates of Saylor, and men also interested in the development of the other mills around about Coplay and Whitehall, noticed these rocks, and Thomas D. Whitaker, of Philadelphia, a successful manufacturer of cotton goods, became interested in property near Phillipsburg, New Jersey, where, after the success of the Atlas Portland Cement Company with rotary kilns, and the American Cement Company with Griffin mills, he established, in 1892, a small rotary kiln plant using fuel oil at Bonneville Station (now Alpha), New Jersey. Associated with him was George E. Bartol, the founder of the Philadelphia Bourse, who later became an important figure in the industry around Easton and Nazareth. This plant proved successful almost from the start, having excellent selling facilities in Boston, New York and Philadelphia, and succeeded in obtaining much large and important work.

After the establishment of this plant, Bonneville, who was always interested in starting new concerns, succeeded in inducing Dr. Filbert of the well-known Vulcanite Paving Company, and his associates, Messrs. Lober,

Widener and Elkins of Philadelphia, to join with him in the building of works near the old Whittaker plant, now the Alpha Portland Cement Company's plant. This project was started by what is now known as the Vulcanite Portland Cement Company, today a large and successful company under the presidency of John B. Lober, who is among the most popular and able of the many able men in the portland cement industry.

The discovery of cement rock back of Coplay station by the American Cement Company resulted in the building of a number of other plants by that corporation, and also led to investigation of the cement resources of the hills in the back country between Egypt and Ironton. As a result, the Lehigh Portland Cement Company of Allentown, Pennsylvania, was established in 1897 by Colonel Harry C. Trexler and Edward M. Young on land near Ormrod. These two men have been associated as President and Vice President of the Lehigh Portland Cement Company since its incorporation, and have seen the small works then established expand to sixteen plants with an annual capacity of 16,000,000 barrels of cement, the output of works situated in all parts of the United States from Pennsylvania to the state of Washington. In the cooperation of these two men, courage and business ability joined hands, and with Charles Matcham, formerly of the Whittaker Company, as superintendent, and his father-in-law, Mr. Ormrod, as wise counsellor, Trexler and Young laid the foundation of what has become one of the greatest organizations of its kind in the country. Since that time other mills have been established in Pennsylvania by the Lehigh Portland Cement Company, which now has one mill at West Coplay, three at Ormrod, and a very large mill at Fogelsville.

It was not long before an attempt to manufacture portland cement from rock took place in New York. Manufacturers there encountered the same difficulties experienced by the Pennsylvania cement makers.

The founder and first president of the Glens Falls Portland Cement Company, Glens Falls, New York, was Captain W. W. Maclay, assistant engineer of the New York Department of Docks, who, as stated by Robert S. Sinclair in a previous chapter, supervised the department tests of cement and did more than any other individual to raise the standard of the product.

The Glens Falls Portland Cement Company, which was organized in 1893 with a capital of \$48,000, estimated as sufficient to erect a plant capable of producing a hundred barrels of cement a day, undertook to manufacture cement, but without results, and in 1894 the capital was increased and two Schoefer kilns were erected with machinery to prepare the materials and reduce the clinker. How the company finally mastered the problems of successful manufacture is described elsewhere in detail by George F. Bayle, now president of the Glens Falls Company.

In the chapter on "Natural Cement" the founding and operation of the Howes Cave Association was described by F. W. Kelley, President of

the Helderberg Cement Company, successor of the Howes Cave Association. It was stated that Charles H. Ramsey, who operated the Howes Cave Association plant, became interested in portland cement about 1884. Mr. Kelley contributed the following additional facts:

For years hard gray limestone had been taken from the cliffs at this place for building purposes. The same material had been manufactured into lime in kilns operated by the Howes Cave Lime & Cement Company, and had also been crushed and shipped as crushed stone. Howes Cave, a long narrow cavern eroded by water action in the hard limestone formation lying over and considerably above the water line, contained large deposits of very finely divided and highly silicious clay. It was from these materials Mr. Ramsey sought to make portland cement. His efforts continued through the eighties and until the experimental plant was built in 1898.

Mr. Ramsey first sought to make portland cement from marl deposits found in local bogs, the marl being combined with cave clay, and later by combining the finely-pulverized limestone with the clay. Prof. Schaefer, of Cornell, made a number of tests for Mr. Ramsey, and George Brown, a Scotchman who died about a year later, spent six months at Howes Cave in 1894, taking samples of marl and clay from fields and from the cave in an endeavor to burn clinker. Melvin Herron, foreman in the natural cement plant, carried on experiments for Mr. Ramsey in 1891-94, and later Prof. R. C. Carpenter assisted in the final experiments which led to the establishment of the present plant.

Mr. Ramsey built a vertical kiln of fire brick about 2 feet inside diameter, 5 feet outside diameter, and about 6 feet high, for use in his experiments about 1895-96. The hard limestone was sometimes pulverized by hand and sometimes in a pan mill about 3 feet in diameter. This pan mill also ground the samples of cement from the clinker which was obtained, and strength and setting tests of the product were then made in the testing laboratory of the natural cement plant. At the time, there was no chemist attached to this laboratory although Mr. Ramsey possessed considerable knowledge of the chemistry of cement. The raw material used in this experimental kiln was wet sufficiently to be made into the form of balls, and when dried these were placed in the kiln with alternate layers of coke. Compressed air from the line which supplied the drills in the natural cement mine was used to give the necessary temperature after the fuel in the kiln had been well started.

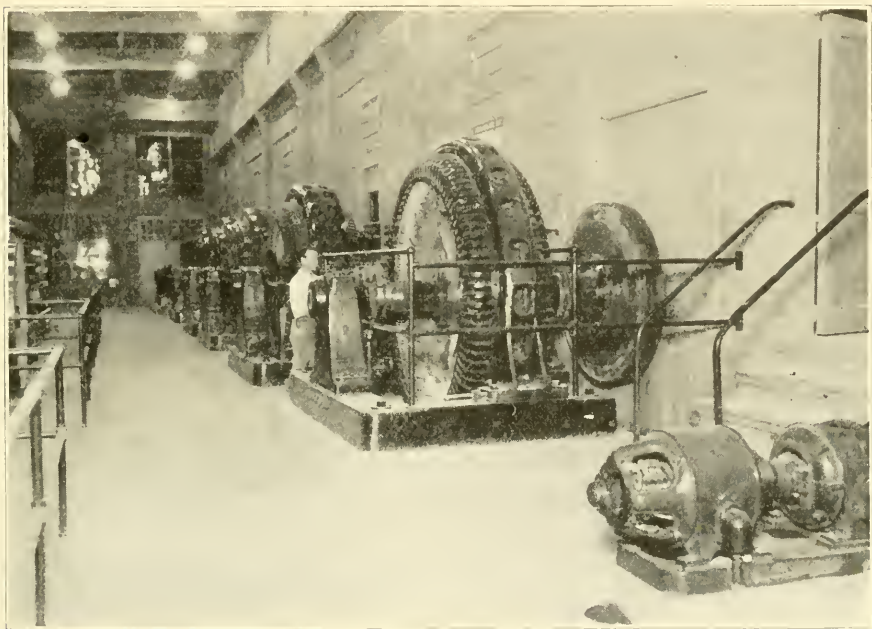
Having demonstrated what could be made from the raw materials at hand, Mr. Ramsey secured sufficient capital to build a small experimental plant, including two 5½-foot by 50-foot Mosser kilns, a 4-foot by 40-foot Mosser drier, a small Farrel jaw crusher, a Bonnet ball mill and Bonnet tube mill, three thirty-inch Griffin mills, and a No. 12 Smidth tube mill. The dry process was tried for a time with bad results, so the wet process was soon installed and continued to date. It was probably the first plant in this country to use the wet process with hard materials.

Oil was first used for kiln fuel, but pulverized coal was soon substituted. In studying the use of pulverized coal, Prof. Carpenter undertook experiments which resulted in a patent on coal burning in rotary boilers. These experiments took place between 1898 and about 1902.

In building the larger plant which followed the successful experimental plant in 1900, alternating current induction motors were used throughout to supply power, and it is believed that this plant was the first cement plant so equipped.

The corporate existence of the Helderberg Cement Company began in 1898, with T. H. Dumary as president. Mr. Dumary was succeeded by F. W. Kelley, who became associated with the company in 1900, having charge of the erection and development of the enlarged plant.

With the growing output of American portland cement and a constantly growing demand, it was idle to suppose that American ingenuity and American capital would permit the field of manufacturing to be confined to the Lehigh district, though that territory was the home of the first works and had materials of unique character and quality for cement



The cement industry ranks tenth among the country's industries in point of total power capacity. The motors shown here operate two-compartment grinding mills.

making. It was already known that the Millens, who were among the pioneers, had used clay and marl at South Bend, Indiana, and the Eagle Portland Cement Company, at Kalamazoo, Michigan, had, in a small way, used similar materials. Consequently, when attention was attracted to the portland cement industry for the reasons above stated, many minds were turned to these old methods and materials. This led to the discovery and the use of marl and clay in many other states, but principally in New York and Ohio. In South Dakota chalk was used. Mills were established to manufacture from marl and clay in these several states and processes were pretty much alike, though varying somewhat in detail. Later the Michigan field was developed.

Concerning the preparation of raw materials, the late S. B. Newberry, writing in 1892, said that while the English wet method gave a perfect mixture, it was quite out of the question in this country, owing to the

labor required and the cost of drying out the very wet slurry obtained by the foreign method. In America the available materials were chiefly shell-marl and clay, both usually in a very wet condition. The semi-wet process was followed almost everywhere. It consisted in charging the materials in a wet state into large iron pans provided with heavy rolls or edge-runners. In these the plastic materials were thoroughly blended. The mixture as it issued from the pans was molded directly into bricks, dried and burned. In one or two cases the brick-making was omitted and the wet mixture spread out to dry on floors heated by steam pipes. It was then cut up into blocks with spades, as commonly the practice in England.

Michigan Marl Plants

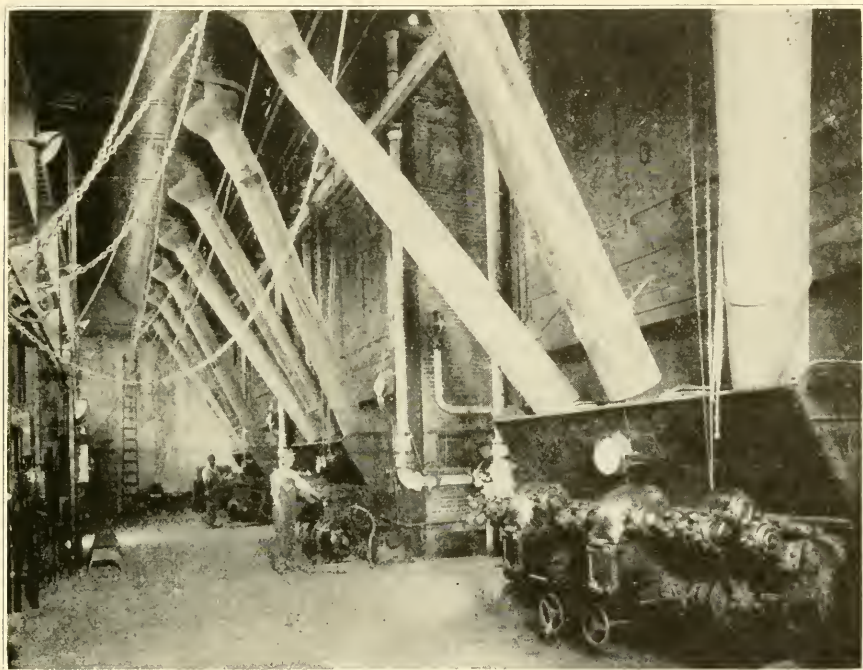
Michigan contained the most promising of all the marl fields in the United States. The history of the industry in that state begins with the pioneer Eagle plant, erected near Kalamazoo in 1885. This plant, whose brief existence has been mentioned, had no successors for a decade or more. Then came the Bronson Portland Cement Company, Bronson, incorporated in 1897, with J. F. Townsend as President. The following year the Peerless Portland Cement Company, Union City, and the Michigan Portland Cement Company, Coldwater, entered the field. L. M. Wing was President and H. S. Bossett, Vice President of the Michigan company, which, in 1902, became the Wolverine Portland Cement Company. The present Michigan Portland Cement Company, of Chelsea* was organized in 1911, the plant occupying the site of the Homer C. Millen works erected in 1903.

That there was an abundance of marl in Michigan had been known for many years, owing to its value as a fertilizer. The United States Geological Survey records of 1900 state that single beds of marl, 100 to 300 acres in area and with an average depth of 20 feet or more, are not rare. The marl is of two well-defined varieties, white and gray, although there is no sharp distinction between them. The purest deposits of white marl are described as being white and fine as wheat flour.

The development of the industry in Michigan was very rapid after the Bronson and Peerless companies began operation. In May, 1901, ten mills were producing cement and six others were in process of construction. The mills then running were provided with nineteen dome kilns and sixty-six rotary kilns, but not all of the latter were then in operation. The capital stock of all the Michigan portland cement companies then organized was about \$25,000,000 and their estimated capacity approximately 8,600,000 barrels per year.

*Plant leased to State of Michigan in 1923; destroyed by fire 1924.

In writing of the Michigan industry in 1901, Israel C. Russell says, that "one of the pleasing conditions observed by the writer during his visits to the several portland cement factories now in operation or being built in Michigan is the manifest ready adaptability of their managers to new conditions, their readiness to adopt new and improved methods, their skill in modifying or reconstructing familiar types of machinery, and



The boiler room of a typical large cement plant helps to generate power equal to the needs of a city of 100,000 people.

their ability to originate and apply new ideas. This healthful condition of the industry, as well as the abundance of raw material, facilities for transportation, excellence of the finished product, increasing demand, etc., insures its permanence and ultimate success."

In the treatment of raw materials, processes were as described above, but an economy was introduced at the Bronson works. The material was prepared in the regular wet way, but the slurry, containing from 50 to 60 per cent of water was introduced directly into the kiln by a pump. This offered new possibilities in manufacture by the wet process through the substitution of rotary for vertical kilns. The Bronson process might be described as a combination of European and American practice. In the preparation of raw materials the methods were like the best European

practice by the wet or humid way, while in burning, the distinctly American practice was represented by the use of the rotary kiln. The marl and clay were first mixed, ground wet, and then run into dosage tanks, where the composition of the slurry was determined.

At the Michigan Portland Cement Company's plant at Coldwater, erected in 1898, blue clay and marl were handled in the wet way and pumped into rotary kilns as slurry containing an average of 50 per cent of water. The kilns were 6 feet in diameter and 60 feet long. Crude petroleum was used as fuel.

In 1899, the Omega Portland Cement Company was incorporated and established a plant north of Jonesville, Michigan. Operations began in 1901 with Frank M. Stewart as President of the company, Dr. W. H. Sawyer, Vice President, Charles F. Wade, Secretary-Treasurer and General Manager, and George H. Sharp, General Superintendent. The company used the wet process, obtaining marl from its own bed immediately adjacent to the plant and clay from Millbury, Ohio. The plant was equipped with six kilns, 6 by 60 feet, and pulverized coal was used for fuel. Bonnot pulverizers were used in clinker grinding. The capacity of the plant was 1,000 to 1,250 barrels per day. The plant operated successfully up to about 1912, showing a profit each year. Around 1912 the price of cement became and continued so abnormally low that in 1914 the company was forced to cease operations.

Other Michigan portland cement companies were rapidly established. Among the earlier concerns were the Alpena, Newaygo and Peninsular Companies, also established in 1899; the Detroit, Egyptian, Elk Rapids, Great Northern, Standard, Three Rivers, Zenith and Wabash Companies, established in 1900; the Clare, Farwell, German, Lupton, Pyramid and Twentieth Century Companies, established in 1901, and the Hecla Company, incorporated in 1905.

Among the men prominently identified with the early history of the cement industry in Michigan, was John W. Boardman, father of John W. Boardman, Jr., Vice President of the Huron and Wyandotte Cement Companies. The elder Boardman was long and actively identified with the business life of the community and became associated with F. W. Cowham in the cement business. He was prominent in the organization and development of the Southern States Portland Cement Company, Atlanta and Rockmart, Georgia; the Western States Portland Cement Company, Independence, Kansas; the Northwestern Portland Cement Company, Mason City, Iowa; the Southwestern Portland Cement Company, Dallas, Texas, and the International Portland Cement Company at Durham, Ontario.

Marl Plants in New York

Marl was also found in New York, and portland cement mills were established at favorable sites. Here the Millens were again pioneers in actual manufacture, though not the first to experiment along this line. The earliest experiments with marl started only a few years after manufacture of portland cement from rock commenced in the Lehigh district. They were conducted in the Rosendale region in 1875-76 by C. F. Dunderdale, at East Kingston, Ulster County, the capital being furnished by Messrs. Cornell and Cuykendall. The marl was brought by way of the Erie Canal from the Montezuma marshes and clay was obtained near the plant. The cement was of good quality but the materials and processes were too expensive to make the experiment a financial success.

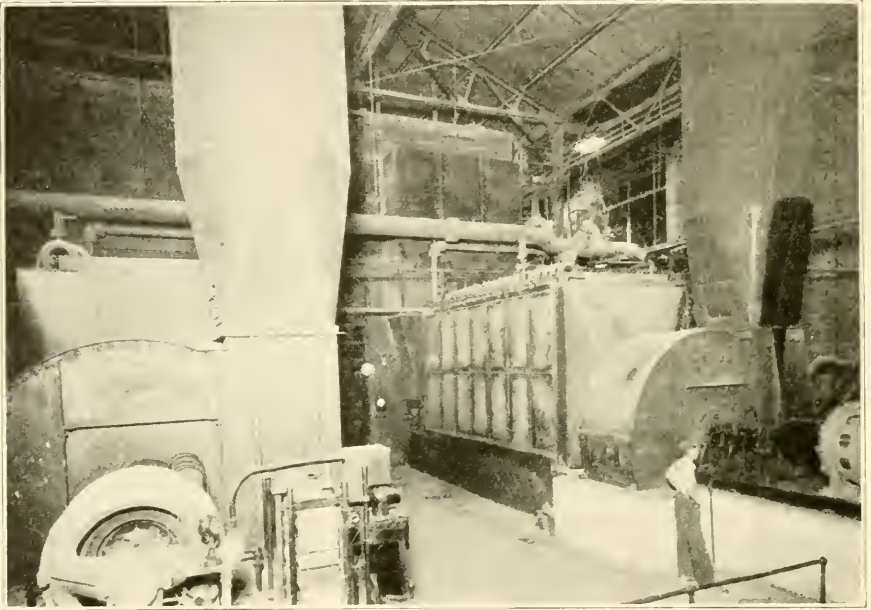
The Millens established the first marl plant at Warner, Onondaga County, in 1886, which they sold in 1890 to the Empire Portland Cement Company. This plant was built on one of the extensive marl deposits adjacent to the Erie Canal. The marl was immediately below the surface of the ground in a bed from 8 to 15 feet thick, underlaid with an abundance of clay. Equipment and methods were representative of some six or eight works subsequently engaged in the manufacture of portland cement from marl and clay by the semi-wet process. The Empire plant had 18 kilns of the regular intermittent dome type, these being 13 feet in diameter and 45 feet high. In 1893 rotary kilns were installed.

After selling their Warner plant to the Empire Company, T. Millen & Company erected a plant at Wayland, Steuben County, New York, at which cement was manufactured from marl. Production began in 1892. The works were destroyed by fire in 1893, but rebuilt the same year.

Among the men prominent in the industry in later years and who had interesting experiences in New York State at this period, was the late S. B. Newberry of Cleveland, President of the Sandusky Portland Cement Company. Shortly before his death he contributed the following:

My interest in portland cement began about 1890 while teaching at Cornell University. My late brother-in-law, Frederick D. White, was financially interested in the Warner Cement Company, whose factory at Warner, ten miles west of Syracuse, New York, had been started under the direction of parties connected with the Solvay Process Company. At this plant marl and clay were mixed, dried and pulverized, and the mixture burned in rotary kilns 4 feet in diameter and 30 feet long. Much trouble was experienced in getting a sound product. The pats showed a pattern of cracks on the surface which led Mr. White to suggest, at a very blue meeting of the directors, that the cement be called "Alligator Brand." He afterwards suggested calling it the "Rooster Brand" because it would not set. At White's suggestion I was asked to go over from Cornell and look into the causes of the difficulty. I soon found that the trouble was due to imperfect burning and defective grinding of the raw materials. Following my suggestions these features of the process were improved and soon a sound product was obtained. By this time the financial affairs of the company were in such shape that an assignment was made and the concern went out of business.

In 1890 operations were commenced at Montezuma, New York, by the Duryee Portland Cement Company, of which George W. Duryee was Secretary. The company owned 1,700 acres of land underlaid by a deposit of marl and clay from 4 to 20 feet thick. The deposit lay below the level



An induced draft fan (left foreground) is used for drawing waste heat gases from the rotary kilns through waste heat boilers and economizers. More than forty cement plants in this country have installed this equipment.

of the Cayuga River and near its banks. The marl, containing about 50 per cent water, was drawn by a steam hoist up an incline into the second story of the works and above the upper end of a mixing machine into which the load was dumped without drying or other preliminary treatment. At the same time a weighed and ground portion of clay was added. The materials mixed as they gravitated toward the lower end of the machine, the entire process being practically continuous. The mixture passed through a stone mill which completed the mixing and ground any coarse materials. From the mill it was introduced directly by screw conveyor into a rotary kiln using oil as fuel. This kiln was sufficiently unique to be described somewhat in detail. It was 75 feet long, and opposite the lower end was a gas retort, or combustion chamber. The chamber was heated by a coal fire and vaporized the oil as it was sprayed into it. The air blast also passed into this chamber, coming from a rotary fan blower. It is claimed that this was the first American plant in which raw materials

were fed without drying or briquetting directly into rotary kilns. The Montezuma works were destroyed by fire in 1893 and were not rebuilt.

Concerning the use of the rotary kiln in New York State, we find J. Gardner Sanderson writing on the subject of the original Navarro kiln in the Rosendale region to John S. Schantz of Milwaukee, under date of February 28, 1890. Speaking of this kiln at the Hudson River Cement Company's plant, which Coykendall owned, he makes the following statements:

I wanted facilities for making practical tests of cement materials from New Jersey and other points, and with that in view entered into an arrangement with Mr. Coykendall to reconstruct the Ransome kiln, adapting it to our process, giving him the right to use the kiln for burning Rosendale cement. The result as to quantity and cost of burning Rosendale cement was so satisfactory that Mr. Coykendall had decided to put in two more of these kilns when an unforeseen difficulty appeared, and which I learned had been apparent to Navarro's people. The cement rock at East Kingston is seamed with pure carbonate of lime, varying in thickness up to an inch or more. In the revolving kiln process this lime is thoroughly mixed with the cement, and it would be impracticable to separate it. In the old lump burning process the rock separates in burning at the seams, most of the lime crumbling into powder, and in drawing, can to a great extent be separated. The Hudson River Cement Company has quarries and kilns near Rosendale which furnish the better quality of dark cement. They are erecting two of the old-fashioned coal-burning kilns at East Kingston in which to burn the light rock, intending to bring dark rock from their Rosendale works to mix with it. The revolving kiln remains and will be employed if they have suitable rock to burn in it. The thorough mixing during the process of burning of the materials fed into the cylinder, is a valuable feature of the revolving kiln process for portland cement and for cement made from a good but slightly variable natural rock.

Additional interest is lent to this from the fact that Coykendall, a number of years earlier, as already described, had started to make portland cement under the Dunderdale patent but was unsuccessful.

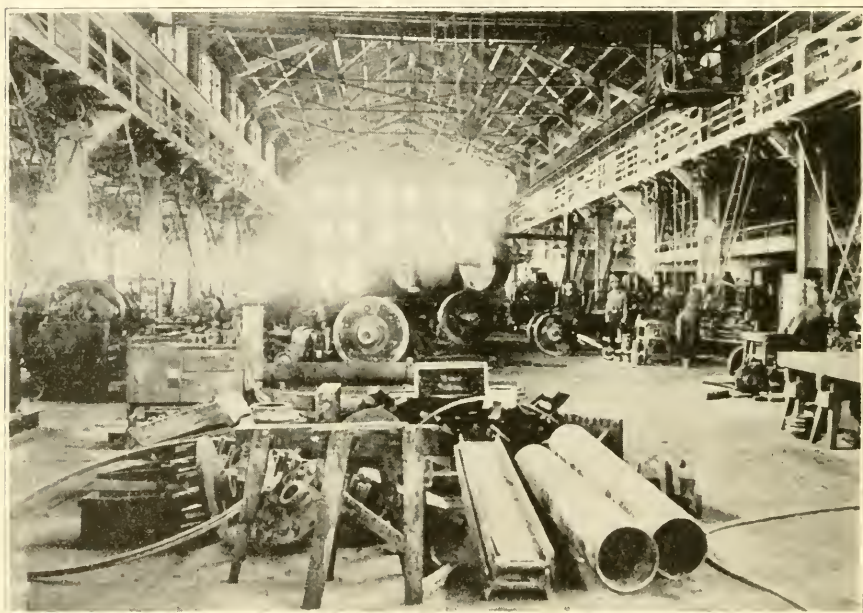
Another marl and clay plant was that of the American Cement Company, two miles east of Jordan, in Onondaga County, erected in 1892. Raw material was obtained from a marsh near the works, and the company also owned a bed of marl near Jordan station. At this plant a wire ropeway transported the raw materials to the mill. The clay was dried and ground separately and then mixed with marl in the pug mills. The slurry was spread over a drying floor and cut into bricks. The bricks were loaded on platform cars, dried in tunnels, heated by coal fires, and fed to twelve kilns of the dome type, coke being used as fuel.

Among the marl-using plants built about 1904 was that of the Iroquois Portland Cement Company, near Caledonia, Livingston County; and in 1896 the Wayland Portland Cement Company built a marl-using plant at Wayland, Steuben County.

In writing of these plants in 1905, Edwin C. Eckel says: "Until within the last few years the typical New York plant has been one using marl and clay, mixing wet, briquetting, and drying and burning in dome kilns."

Ohio Marl Plants

In Ohio the Buckeye Portland Cement Company established a plant near Bellefontaine, in 1889, the promoters of this enterprise being G. W. Bartholomew and associates. They had a double Dietsch (German) kiln. Mr. Bartholomew was previously connected with the San Antonio Portland Cement plant in Texas, and was familiar with foreign practice. The Buckeye Company had an abundance of soft white marl near blue clay. Later, four continuous shaft kilns, similar to the Candlot type, were built on designs prepared by the company. The raw material was introduced in



The machine shop is a vitally important part of any modern cement plant because of the necessity of keeping the equipment in perfect condition all the time.

the kiln in the form of bricks, but later a rotary kiln was introduced and proved so satisfactory that plans were made for the installation of others to escape the brick-making, drying, etc. This company also experimented with powdered coal for rotary kilns, which was reported to be satisfactory. Crude petroleum was the first fuel used.

Even earlier than the plant described above was a very small works at Columbus, Ohio, operated under the name of the Murphy Cement Company. It consisted of a single iron kiln lined with fire brick and a lot of junk in the shape of crushing and grinding machinery. The plant used limestone and clay and had a capacity of 30 to 40 barrels a day. It was in existence only a short time.

S. B. Newberry went to Ohio where he was interested in the establishment of a marl plant. Concerning this plant he wrote as follows:

My experience in New York led me to believe in the possibilities of the portland cement industry in this country, and with Frederiek D. White I explored reported marl deposits in northern Ohio, finally locating large deposits of white marl in the neighborhood of Sandusky. With the help of my late brother, Arthur St. John Newberry, of Cleveland, a small company was formed in 1892 and a plant erected at Bay Bridge, near Sandusky, which turned out its first product in August, 1893. In the course of our explorations, Mr. White and I visited the Buckeye cement plant near Bellefontaine, Ohio, where cement was made in vertical kilns from marl and clay. In order to conceal the purpose of our inspection, Mr. White asked the superintendent if the product they made was a liquid cement like Le Page's. This showed such a depth of ignorance that the superintendent had no hesitation in admitting us.

Chalk Plants

Here and there companies were formed to manufacture portland cement from chalk and clay.

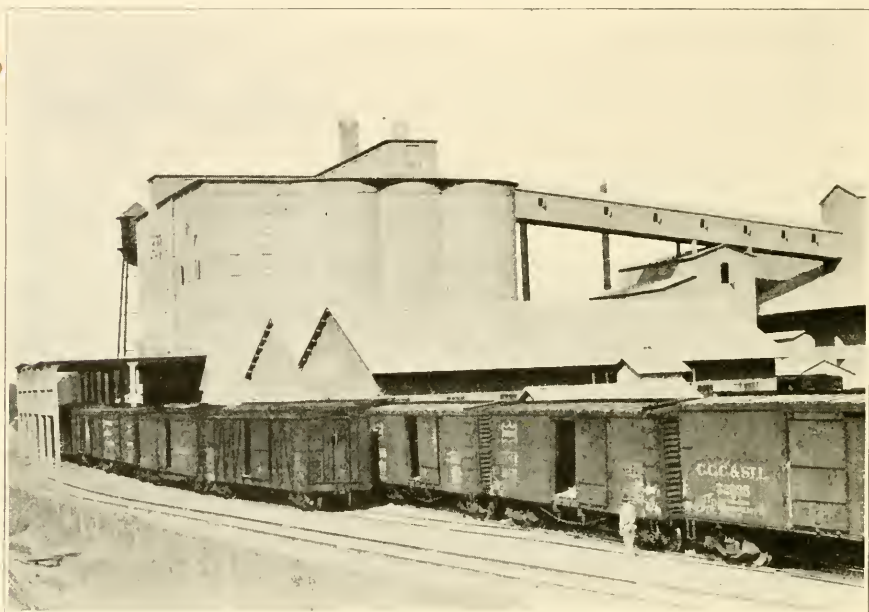
On the north side of the Missouri River, four miles west of Yankton, South Dakota, is an outcropping of chalk. Here, in 1889-90, a portland cement plant was erected by the Western Portland Cement Company, of which W. Plankinton, of Milwaukee, was President; D. J. Whittemore, formerly President of the American Society of Civil Engineers, Vice President, and John Johnson, cashier of the Wisconsin Marine & Fire Insurance Company's bank, Secretary and Treasurer. The plant was designed by Robert Yates, who had studied works in England and Germany, and it was patterned along the lines of plants on the Thames and Medway, England. Kilns were of the Johnson type, of which there were six with drying chambers and central chimney. A homogeneous mixture of chalk and clay was obtained by conveying all material in continuous courses through three sets of bassins dosseurs. Later this plant was sold to S. B. Newberry, of the Sandusky Portland Cement Company, who dismantled it as scrap.

In 1895 a chalk plant was established at Whitecliffs Landing, on Little River, Arkansas. Litigation between those financially interested arose, resulting in the closing of the plant in 1900. Operations were resumed in 1901, with the name of the company changed to the Southwestern Portland Cement Company. The works contained the most improved machinery made at the time. Four continuous dome kilns were used to burn the bricks, which were made of chalk and clay.

Until 1900 the nearest cement plant corresponding to the Whitecliffs works was at San Antonio, Texas. Then a plant was erected at Dallas, Texas, where chalk from the southern extension of the Whitecliffs formation was used.

Another early chalk plant was that of the old Alabama Portland Cement Company, organized in 1901, now the Gulf States Portland Cement

Company. In Brown's "Directory of American Cement Industries," published in that year by Charles Carroll Brown, it is stated that the Alabama Portland Cement Company, whose works were then under construction, had a capitalization of \$500,000 and a capacity of 1,000 barrels per day.



The modern cement storage and packing-house provides enough room for thousands of tons of cement and is equipped with the latest labor-saving machinery.

Thomas C. Cairns was General Manager. In the 1904 edition of the same publication appear the names of J. Topham Richardson, President; Bristow Bovill, J. L. Spoor and C. A. W. Moon, Directors, all of London, England. Mr. Cairns had become a Director in the meantime, and F. W. Smyth had become General Manager. The main office of the company was at Demopolis, Alabama, and the works at Spocari. The capacity in the 1904 directory was given as 500 barrels per day.

George P. Dieckmann, Vice President and General Manager of the Gulf States Portland Cement Company, relates the following interesting incidents connected with the original works:

The Alabama Portland Cement Company manufactured the well-known "Red Diamond" brand. The company was organized in 1901 but the plant was shut down from 1908 to 1919, during which period several attempts were made to renew operations. The company was organized by English capital. The name Spocari, at which place the plant was located, originated in the following manner: Mr. Spookes (probably Spoor), Mr. Cairns and Mr. Richardson, in seeking for a name, selected the first two letters of each of their names which made "Spo-ca-ri." According to darkey legend, however,

Spocari was the Greek for "cement." It may be of interest to state that the Gulf States Portland Cement Company owns its coal mine, is located on a navigable river and is in position not only to ship coal by river but also cement. I believe it is the only plant in the United States having these advantages and the only one having no quarry.

The calcareous material used for the manufacture of cement is obtained by a so-called excavator, which is a motor-driven apparatus, and works on the principle of a shaving machine. It shaves off a 50-foot face, and from the cutting knife drops these shavings into the buckets following the cutting knives. In other words, it is an elevator provided with cutting knives and driven with a motor delivering the stone without the use of crushing machinery. This apparatus can be operated by two men.

We find in other sections of the country listed as engaged in the manufacture of portland cement as early as 1901, the Alma Portland Cement Company, Wellston, Ohio, B. B. Lathbury, President; Buck Horton Portland Cement Company, with works at Manheim, West Virginia, John F. Storer, President; Castalia Portland Cement Company, Castalia, Ohio, W. J. Prentice, President; Chicago Portland Cement Company, Chicago, Norman D. Fraser, President; Colorado Portland Cement Company, Portland, Colorado, W. H. James, President; Diamond Portland Cement Company, Cleveland, Ohio, Z. W. Davis, President; German-American Portland Cement Company, Chicago, Carl Prussing, Germany, President and Fritz Worm, Chicago, Secretary; Iola Portland Cement Company, Iola, Kansas, Sheldon H. Bassett, President; Marquette Portland Cement Company, La Salle, Illinois, of which the Dickinson Cement Company, Chicago, were sales agents; Maryland Cement Company, Baltimore, Frank H. Sloan, President; Pembina Portland Cement Company, Grand Forks, North Dakota, E. J. Babcock, President; Portland Cement Company of Utah, Salt Lake City, Frank Richardson, London, England, President and Thomas C. Cairns, General Manager; Texas Portland Cement Company, Dallas, Texas, Leon Blum, President; Virginia Portland Cement Company, with works at Craigsville, Virginia, W. R. Warren, President.

CHAPTER VIII

DEVELOPMENT OF THE INDUSTRY

Some Figures on Early American Production

From what the reader has thus far learned of the early days of the cement industry in America, has no doubt come a realization that its pioneers had difficulties of every type to encounter, financial, mechanical and scientific. At the end of the first decade of their work, 1870 to 1879, the total output of American portland cement as shown by the United States Geological Survey records had reached only 82,000 barrels, valued at \$246,000, while importations, as shown by official records, amounted to 92,000 barrels for 1878, the earliest figures recorded, and 106,000 barrels in 1879.

The next twenty years were full of interesting developments in the field, new figures appearing in the foreground and new methods finding their way into the art.

Comparison of Growth of American Industry with that in Germany

In order to realize, in a way, how the production and growth of the American industry followed that of Germany, and how similar were the difficulties encountered in both countries, one need but refer to the papers of Max Gary, the distinguished German expert, and Henry Faija, M. Inst. C. E., read at the Engineering Congress of the United States during the Columbian Exhibition, Chicago, 1893, and the paper by Robert W. Lesley, Assoc. Am. Soc. C. E., read at the International Engineering Congress in St. Louis in 1904. Gary's paper showed that the German Portland Cement Manufacturers' Association started in 1877, and represented at that time 29 factories, with an output of 2,400,000 barrels, while by 1903 the membership of the Association comprised 94 works, with an estimated production of 22,000,000 barrels. Both Gary's and Faija's papers describe fully the methods of manufacture used at that time in Germany and England and give details of processes, machinery, etc. In the description of manufacture in both papers much stress is laid upon the wet slurry, its proper drying, the advantage of wet grinding, and the method of handling the material after it had been dried by evaporation and decantation. Much is said of the advantages of the wet mixture; of the large area required for drying, the use of new types of drying tunnels attached to the old-style

dome or bottle kilns; of drying floors utilizing the heat that formerly went up the stack of the old dome kilns; and of other methods for economical working of the wet mixture in the intermittent kilns then used.

There are also descriptions of the introduction and use of the Schoefer continuous kiln, the Dietsch continuous kiln, and the Hoffman-Ring kiln.

Some of the Early Mechanical Practices

So far as machinery was concerned there was little said, because in general the raw material was ground wet in large revolving vats with chasers, and the finished material on French buhr stones. European practice had been very largely based upon precedent. The first mills having been situated along rivers where wet chinks and clay were easily obtainable, the machinery was arranged for that purpose, and as water was abundant the precedents for mill power were water power, and the line shaft for driving mills was usually connected with a water wheel, and the mills were in turn connected with the line shaft by bevel or other forms of cog gearing. Thus the grinding machinery in many of the European works was situated in the second story of the building, losing considerable space, and the well-known forms of millstones used for grinding varied in size from three to six feet in diameter. As time went on, mills in many of the more advanced European plants were driven directly by belts from line shafts, which took the place of the old-fashioned cog gearing, and in several of them the first type of tube mill was used, the apparatus, consisting of a revolving cylinder containing a large number of Iceland pebbles.

In his paper of 1904, Lesley describes visits he made to the principal portland cement works in Germany, France and England, and with the information furnished by the contributions of Faija and Gary, he secured a fair insight into the status of the industry at the period mentioned. In describing this he says:

The first interesting fact is that up to 1896 precedents in burning and grinding governed cement manufacture, and few radical changes were introduced. This seemed to apply more extensively to this than to any other industry then known to the writer.

The milling or grinding of materials, as a rule, had always been done by water power. Water power had fixed the mode of grinding by millstones operated by water-wheels with bevel or cog gearing of one kind or another, between the power and the running parts. This method seemed to obtain in most of the mills in Europe, even though steam power had been adopted, and it was perfectly practicable to run millstones or other forms of grinding machinery by direct belting and shafting.

Experience had shown that wet materials could be mixed intimately in a liquid or semi-liquid condition, that the sun and air would dry the paste thus made into a mass which could be easily broken up, and which, after drying upon heating floors, could be burned in dome kilns, and that the clinker thus produced, when properly selected, was easily ground, producing excellent results. All these traditions as to methods of manufacture were interwoven with the reputation which old mills—more especially in England

—manufacturing well-known brands of cement, had won for their product, and very few establishments in Europe in the early nineties had made much progress toward change in methods.

The same traditions governed the first manufacture of American portland cement. It was difficult to induce engineers and large investors to trust important construction to cements made of new and untried materials in a new country. It was even more difficult to induce them to consider any portland cement which had been made under methods showing any change from the well-known processes which had established the reputation of portland cement as a building material all over the world.

The early manufacturer in the United States had difficulty enough in persuading architects and engineers to use this material at all, and it was only upon the statement that, in chemical constitution, its ingredients were similar to those of the well-known portland cement of Europe, and that it was made by similar processes, that he was able to get a hearing. There was difficulty enough to achieve this result without securing the consent of the engineer to use material made, not only from new ingredients, but also by new processes.

American portland cement, in the nineties, had to show its right to exist as an engineering material, and its right to be trusted with the duty of carrying the strains which are now expected of it. The well-known and successfully-made brands of England and Germany had carried the burdens imposed, and had carried them well, and the market was at their command. During the past ten years, however, American portland cement has been steadily making its commercial and scientific reputation, and, these facts having been established, it became possible to adopt new methods and new machinery in almost all branches of the industry.

Owing to peculiar conditions as to labor, fuel, etc., American manufacturers found themselves handicapped, in the early days, when manufacturing under the European processes, and it became a part of their struggle for existence to challenge the old process, and to develop new ones, under which they could expand, not only in the United States, but in all the countries of the world.

From the foregoing the lack of mechanical progress in the early American plants can well be understood, and it was not until the period between 1880 and 1900, when American portland cement began to establish its foothold, that American manufacturers started in on the remarkable career of mill and kiln developments which have signalized the growth of the industry in this country.

The output of portland cement during this time was 150,000 barrels in 1885; 335,500 barrels in 1890; 990,324 barrels in 1895, and 8,482,020 barrels in 1900. With this growing demand for the American product and the gradual reduction of imports, American manufacturers were alive to every promising method of improving their manufacturing processes.

Lehigh District, Pennsylvania, First Important Manufacturing Center

As a historical fact, figures show that the real, early growth was in the Lehigh district in Pennsylvania. This was largely due to the remarkable raw material found in that field. In other words, the making of portland cement was largely an admixture of clay and chalk, limestone and clay, shales and limestone, and other similar materials, but in practically

every case, except in Boulogne, France, the product was the result of the combination of two or more raw materials. In the Lehigh district, which in the early days embraced the large strip of territory running from the Delaware River near Martins' Creek and extending through Bath, Bangor, Nazareth, Northampton, Coplay, Whitehall, Egypt, and Ormrod,



Twenty years ago each filled sack was tied and weighed by hand, a tedious and inefficient process.

there existed a wonderful deposit of argillaceous limestone, such as has not been found in like extent and quality in any other part of the world. This deposit, of almost unknown depth, was sedimentary material, and occupied geologically a position between the slates and limestone formations. It partook, in a general way, of both materials, resulting in the combination of limestone and argillaceous material already described. Owing to their sedimentary character, they were, as a general rule, of moderate hardness, as contrasted with crystalline limestone and in many cases partook of the characteristics of slate. Thus, they were easy to grind and to handle, and in the early days of the industry, when tensile strength standards fixed by engineers were not too high, many of these rocks were almost adapted to portland cement manufacture in their original state without the addition of limestone. Even today in some of the choice locations materials are found that contain practically all the ingredients properly proportioned for portland cement.

Thus it was that once manufacture had started in the Lehigh district, a large body of workmen and managers familiar with the material were soon found, and the district manufactured, from 1890 to 1896, about 60 per cent of the total output of the United States; from 1897 to 1900 inclusive, slightly more than 70 per cent, gradually declining thereafter until in 1923 it produced but 25.9 per cent of the total output in the country.

Another feature of this material was that it was dry and did not require for its handling the large bodies of water needed in the European wet process where wet materials were the ingredients. The rocks were laminated water-lime rocks, and by reason of their chemical composition, as well as their structural character, were specially adapted to the manufacture of portland cement. Consequently, in Saylor's day, it took much less time to handle and dry this material than it did with the over-saturated European slurry; and Saylor found that by adding burned natural cement rock of quick setting type to his paste he was able to handle his brick on his drying floors at very early periods.

Along in 1883 and 1884, under the DeSmedt process, great economies were being made with this same raw material at the works of the American Improved Cements Company.

These American methods, however, at that period were easily explainable to the average engineer as the analysis of the raw mix was identical with the raw mix used in Europe, and therefore there was no material difference in the methods of manufacture of the American product as contradistinguished from that of Europe, the rest of the steps being practically identical with those pursued abroad.

During this twenty-year period, however, American ingenuity was constantly thinking in new terms in the manufacture of portland cement, and the period marks the development of two great lines of progress, each of which was in itself a master key.

High Labor Costs Met by American Ingenuity

The American manufacturer was confronted from the earliest days of the industry with high-priced labor, and economy in this direction was one requisite of success. Two fields for advanced thought offered themselves: On the one hand, the necessity for some improved form of kiln whereby, with costly American labor and cheap American coal, the process of clinkering could be accomplished at a lower cost in this country than in Europe. The other, the bringing forth of new machinery for crushing and grinding the raw rock, which in American practice had taken the place of the softer material used in Europe. Upon these two lines of development rests the whole American industry today, and a few words as to this are most pertinent in dealing with this period of the business.

The light iron crushers of coffee-mill type were constantly breaking down, and cost money in time and repairs, while the buhr stones used for grinding both raw material and the finished product were the source of unceasing expense for picking and dressing. From this necessity grew the introduction of the Gates crusher, the first of these great machines in operation in the industry being used at the works of the American Improved Cements Company, at Egypt, Pennsylvania. While in some mills the Sturtevant, Frisbie and some similar forms of iron and steel grinding apparatus had been introduced to take the place of mill-stones, it was not until 1887 that the advent of the Griffin mill marked a new era in cement mill grinding machinery.

In reference to this particular mill, which is used, together with the Gates crusher, for the purpose of illustrating standard types of iron and steel crushing and grinding machinery which marked the development of the American industry in the period of its growth between 1880 and 1900, it was this development in the substitution of heavy, high-power steel machinery that was of the greatest importance.

The names Griffin and Gates will always be identified with the industry because of the important mechanical devices described.

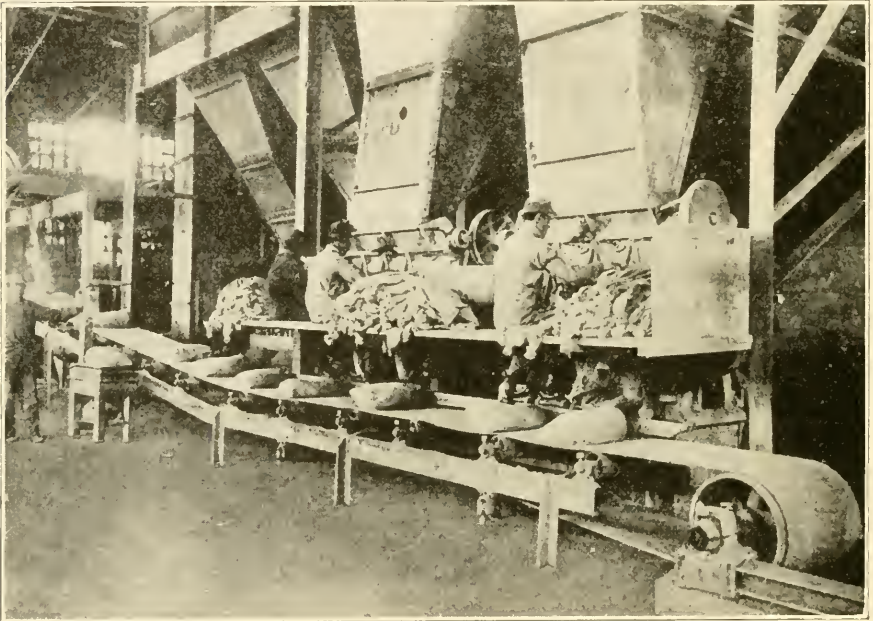
Edwin C. Griffin died on December 10, 1911, in Boston. Mr. Griffin, who was a native of Ontario, Canada, was born January 29, 1848. Owing to the importance of his inventions, chief among them the Griffin mill, he was as well known in the cement industry, both at home and abroad, as any of the leading manufacturers of cement. Mr. Griffin was a son of James K. Griffin, inventor of the original single roll mill that bore his name.

Ralph I. Gates was one of Chicago's pioneer citizens as well as an early manufacturer of cement. He died in Chicago on January 16, 1907, at the age of 67 years. He was a native of that city, and a son of Philetus W. Gates, one of the first manufacturers in what was then called the Far West. For many years he was treasurer of the Eagle Works Manufacturing Company, which was succeeded by the Gates Iron Works and Fraser & Chalmers. He severed his connection with the Gates Iron Works Company in 1887 to become secretary-treasurer of the Anglo-American Portland Cement Company, later merged into the Chicago Portland Cement Company.

CHAPTER IX

THE MECHANICAL SIDE OF THE INDUSTRY

This chapter is largely given over to recounting the development of the mechanical side of the portland cement industry in this country. Here American resourcefulness and inventive genius stand out at every



Modern cement packing machinery is the last word in mechanical ingenuity. Each sack, when automatically filled from a spout, receives exactly 94 pounds (one cubic foot) of cement. Then the flow stops, the filled and tied sack is shot onto a belt conveyor, loaded onto hand trucks, and wheeled to waiting freight cars or motor trucks.

turn. However, the mechanical side of the industry in this country was not developed without those difficulties which attend pioneer efforts to replace the old by the new.

The initial use of mechanical appliances in the cement industry is at the source of the raw material, and may be placed under the head of excavation. There are three general methods of excavating raw materials: quarrying, dredging and mining. The materials extracted by these methods are limestone, cement rock, marl, clay and slate or shale. It has been estimated that over 30,000,000 tons of raw material were handled in

1913 to produce 92,000,000 barrels of cement, and that at this time about 85 per cent of all material used was quarried.

The excavation of limestone, cement rock and shale is usually a quarrying operation, and with few exceptions a hillside proposition. In rare instances it is a mining operation.

The successive steps in quarrying are stripping, drilling and blasting, excavating and transporting. Sometimes difficult problems occur in the drilling and blasting operations, owing to variations in the hardness of material or its structural formation.

Clay is dug from pits, and marl, in most cases, is dredged. At some sources of supply, marl is extracted with pumps. When marl is under water, steam dredges mounted on barges bring up the raw material. Where the deposit is saturated, it is often the practice to drain the water into channels upon which float the barges carrying the dredges. The material is conveyed by barges to a wharf and thence to the mill.

The machinery used in stripping and excavating raw material from quarries, clay pits and marl beds includes shovels, scrapers, graders, steam shovels, scraper bucket excavators, locomotive cranes and floating dipper dredges.

Transportation methods used to convey the raw materials to the mill include gravity, elevator, hauling, serial conveying and pumping systems; and the machinery and appliances include wheelbarrows, wagons, dump cars in trains, aerial tramways or cableways and marl pumps.

As preliminary crushing and grinding of the raw material and the final grinding take place before and after burning, the kiln will be described first.

The Kiln the Most Important Mechanical Unit

The mill side of the portland cement industry involves the use of mechanical devices of many kinds, but the most important unit is the kiln, the receptacle in which raw materials are burned. The capacity of a plant is usually determined by the number of kilns in use. The kiln was a legacy from the old lime burners to the natural cement makers and they in turn passed it on to the makers of portland cement. The kiln has ever been a source of inspiration to inventors, resulting in innumerable patents or changes in types or parts thereof. From the first primitive furnace of the lime burners, cement kilns improved until there was finally evolved the great rotary cylinders which virtually revolutionized the business of making portland cement in so far as economy of operation and increased volume of production are concerned.

In the manufacture of natural cement, which was made from raw rock, the material was simply placed in the vertical kiln with alternate layers of low-grade coal and burned without previous manipulation or treatment.

Wet, Semi-Wet and Dry Processes Described

Portland cement, which is made in some cases from rock and in others from marl and clay or limestone and clay, required considerable preparation of raw materials before burning. It was manufactured by three



A fine example of concrete building construction in cement plant office and laboratory.

methods, known as the wet method, semi-wet method, and dry method, all of them mechanical until the stage of burning was reached, and all intended to bring about thorough combination of the different ingredients of the raw material.

The wet method was usually employed where the raw materials consisted of chalk and clay. During the crushing or grinding operation water was used to bring about an intimate mixture. The mixture was then run into settling "backs," some of them covering acres of ground. There evaporation and decantation took place, thus disposing of a large amount of water. After further drying in the vicinity of the kiln, the mixture was placed in the kiln with alternate layers of fuel and burned.

In the semi-wet method, a French invention, the mixture, after grinding and wetting, was passed between horizontal mills in semi-plastic state and then placed on the drying floors and later burned as described in the wet method. In the wet and semi-wet processes, the materials in the wet

state were called "slurry"; and where the wet method was used months might elapse before the material was dry enough to go into the kiln.

In the third, or dry method, the raw material as treated in the early days of the portland cement industry was first reduced in the dry state by crushing and grinding machinery and then given sufficient water to transform it into a plastic mass which was molded into bricks. The bricks were dried and then burned as in the two methods previously described. But upon the advent of the rotary kiln the dry process became literally dry, no water being used. The materials are now crushed and ground to a fine powder, which is fed directly into the kiln and burned.

Before the days of the rotary kiln one difficulty experienced by American manufacturers was due to lack of binding quality in the raw material after being placed in the kiln. The American materials, not being as plastic as the European chalks and clays, the lower contents of the kiln would settle under the weight of the upper charge. At Saylor's plant, quick setting natural cement was used as a binder for the brick and another ingenious method devised by the American Cement Company has been described.

Three types of kilns have been used in the manufacture of portland cement in the United States, the intermittent vertical dome kiln, the continuous vertical kiln and the rotary kiln. American manufacturers used the old vertical continuous kilns for making natural cement and, later, in the manufacture of portland cement.

The Dome Kiln

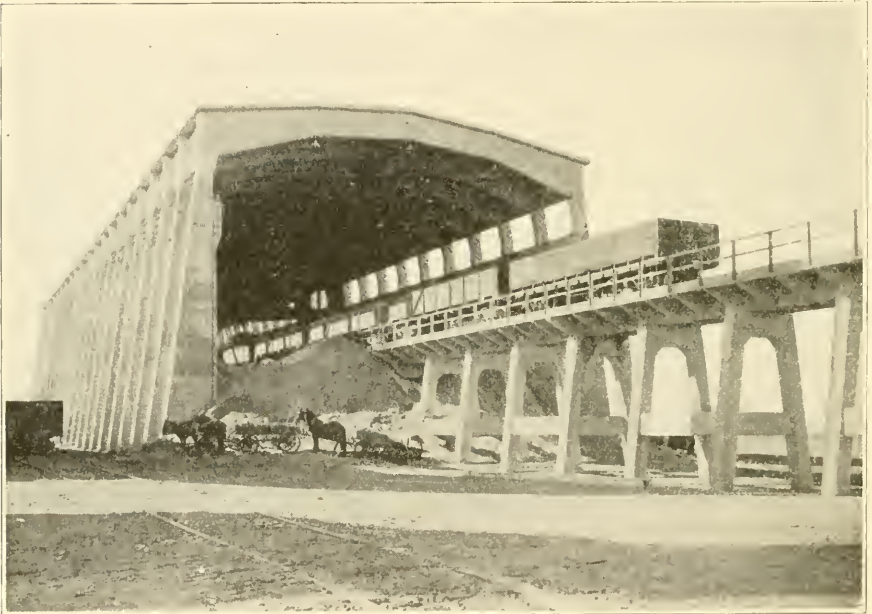
The upright dome kiln, the first type used in America, was not operated continuously, each burning requiring a fresh charge, hence the name intermittent kiln. It was also called the bottle kiln, owing to its shape. Having been burned with alternate layers of coke, the material was extracted from the bottom of the kiln and sorted for overburned and underburned clinker. The first portland cement made from the Lehigh rocks by Saylor was burned in a dome kiln, and also the marl cement of the Millens at South Bend.

The uneconomic features of the dome kiln soon became apparent. The labor costs involved in the charging of the kiln were high and the output was limited.

A great deal of heat escaped from the top of the kiln, and as drying of brick before burning was essential, it was logical that the utilization of waste heat for this purpose should be suggested to the inventor. I. C. Johnson, of England, invented a kiln from which the heat ascended and entered one end of a long horizontal chamber built above the kiln. Brick were placed there to dry while those previously dried were being burned in the kiln. The Western Portland Cement Company, of Yankton, South Dakota, installed kilns of this type.

The Continuous Kiln

The disadvantages of the intermittent kiln led to further improvements, and finally there was invented in Germany the continuous kiln, charging being carried on continuously at the top and the clinker drawn from the bottom. These kilns were several stories in height and continuous charging made for economy in the use of fuel. The two important kilns of this type used in America were the Schoefer and Dietsch kilns. The Dietsch kiln had three chambers for heating, burning and cooling



Modern cement plants contain many examples of the adaptability of concrete to industrial construction.

the material. The dry slurry passed into the heating chamber and from there was raked into the combustion chamber. The removal of clinker from the bottom permitted the slurry to drop into the heating chamber where it was gradually subjected to high temperature preparatory to going into the combustion chamber. The Schoefer kiln was a modification of the Dietsch kiln, and worked upon the same principle.

The Rotary Kiln

When kilns of the foregoing types were first introduced in the United States in an experimental way, demand for better methods of burning cement was imperative, and concurrent with the introduction of the kilns

described came that great invention, the rotary kiln, then in the initial stage of development. The rotary kiln, which finally supplanted the more primitive types in all important cement works, consists of a long cylinder of sheet steel lined with firebrick. These kilns had been made in varying lengths, but a prevalent dimension for some years was 60 feet long by 6 feet in diameter. The kiln, which rests at a slight incline, revolves on tires resting on trunnions. The cement-making material is fed into the upper end, which projects into a brick flue surmounted by a stack. Where portland cement is made from rock, the material is reduced to a fine powder before it enters the kiln, where it is burned at temperatures of 2500 degrees to 3000 degrees F., which transforms it into "clinker." The clinker is ground to the fine powder known as portland cement. In the case of marl, the raw material in the form of slurry is pumped from vats into the kiln.

The First American Rotary Kiln

How the first rotary kiln in America was installed is an interesting story. The following account is contributed by Alfonso de Navarro, Vice President of the Atlas Portland Cement Company, whose father, Jose F. de Navarro, was responsible for the introduction of the rotary kiln in the United States.

In 1886, Jose F. de Navarro and his two sons, Antonio and Alfonso de Navarro, erected in the United States the first rotary cylinder for the burning and manufacture of cement. This cylinder was erected under patents taken out by Henry Mathey, which were controlled by the de Navarro family.

The cylinder was erected at the Union Cement Company works, Rondout, New York. It was 24 feet in length with a diameter of 12 feet, and was similar to a large peanut roaster. This cylinder was charged from the center up to one-third of its capacity. The fuel used in the burning of the cement rock was crude Lima oil. The market price of this oil was from 2 to 2½ cents a gallon, delivered. The burner used was known as a Rose burner. The cylinder was slowly revolved for eight or ten hours, after which time it was discharged from the same aperture that it was charged. After two years of experiment, it became evident that this cylinder was a failure and it was abandoned.

Jose F. de Navarro, by chance, saw an article in the *Engineering News* describing a rotary cylinder process for burning cement, which was being experimented with by Frederick Ransome, at the Gibbs Portland Cement Works, at Grays, on the Thames, England.

Alfonso de Navarro in January, 1888, went to England, and with a letter of introduction to Mr. Ransome from the Baring Brothers, visited the works where the rotary cylinder was in operation. This cylinder was 5 feet in diameter and 25 feet long and was similar in construction to the cylinders now in operation throughout the country. The fuel used by Mr. Ransome was producer gas, and the material manufactured by this process was of the best quality, samples of this cement being taken from the cylinder by Mr. de Navarro and tested by a London cement expert.

The cylinder then in operation was the third erected by Mr. Ransome, the first cylinder being 18 inches in diameter and 12 feet long and the second cylinder 2½ feet in diameter and 18 feet in length.

After several months of negotiation, Mr. de Navarro acquired the American rights for the manufacture of portland cement under the Frederick Ransome patents.

In July, 1889, an exact duplicate of Mr. Ransome's last rotary cylinder was erected by the Keystone Portland Cement Company, which was controlled by the de Navarro family, at Coplay, Pennsylvania, and in November, 1889, operations under this process were begun. At first the experiments were unsuccessful and the product unsatisfactory, owing to the fact that the cement rock was burned in small pieces varying from half-inch to 2 inches in diameter.

In the Spring of 1890 it was decided to grind the raw material to an impalpable powder and to adjust the proportion of lime and silica thoroughly before the material was delivered into the cylinder. The product, after having been thoroughly burned and thereafter ground to a powder, 95 per cent of which would pass through a No. 50 sieve, produced a portland cement which compared favorably with the best English and German brands. At this time the Keystone was changed to the Atlas Cement Company, being still under the same ownership.

It soon became known in the portland cement world that the rotary cylinder process was a practical and economical method of manufacturing portland cement and that the product was superior to that manufactured by the old vertical kiln process. It was but a few years thereafter when the process for the manufacture of portland cement was completely revolutionized and for the past twenty-five years all portland cement works have been erected and operated throughout the world under the Frederick Ransome rotary cylinder process.



Group of cement men at St. Louis in 1903, just before the opening of the World's Fair, including (1) Ernest R. Ackerman, (2) John B. Lober, (3) Robert W. Lesley.

The size of rotary kilns continued to increase until a maximum length of 260 feet was reached, the Edison portland cement works, under patents granted to Thomas A. Edison, being the pioneer in the installation of

kilns of extreme length. The following table gives the lengths of rotary kilns in active plants in 1917-1923, and also discloses fluctuations in the number of kilns in use during that period:

LENGTHS OF ROTARY CEMENT KILNS IN ACTIVE PLANTS IN THE UNITED STATES, 1917-1922

LENGTH (FEET)	NUMBER OF KILNS					
	1917	1918	1919	1920	1921	1922
40 to 60.....	108	77	71	74	74	78
61 to 99.....	94	90	87	87	87	91
100 to 109.....	84	105	98	98	91	102
110.....	83	65	55	66	56	54
120.....	88	88	95	97	99	101
125.....	194	183	166	172	164	162
126 to 149.....	65	63	63	63	64	66
150 to 199.....	73	{ 63	66	73	76	75
200 to 260.....			19	23	29	31
	789	749	720	753	740	760

Kiln Fuels

The fuel customarily used in burning portland cement in the rotary kiln is powdered coal, but a number of plants use crude oil and a few natural gas.

The records of 1922 are noteworthy in showing that over 75.7 per cent of the portland cement produced was burned with coal alone, a decrease from 81.5 per cent in 1921. Records from 1907 to 1921 show that the percentages of cement burned with powdered coal ranged from 81.2 in 1920 to 88.5 in 1907 and ran generally about 82 per cent. Increased consumption of crude oil and natural gas, due to the greater abundance of crude oil for fuel in 1922, accounts for the difference.

KILN FUELS
PORTLAND CEMENT BURNED BY DIFFERENT FUELS IN 1922

	Number of Plants	Number of Kilns	Barrels of Cement	Per- centage of Total
Coal.....	90	590	86,864,274 12,030,542	75.7
Coal and oil.....	7	64		10.5
Coal and gas.....	1	6	12,794,890 3,100,278	11.1 2.7
Oil and gas.....				
Oil.....	17	85		
Coal, oil and gas.....	2	8		
Natural gas.....	1	7		
	118	760	114,789,984	100.0



The eighteen-story, reinforced concrete Hide and Leather Building, New York City, when erected, was the tallest concrete building in the world. It is of further interest that it was built during winter weather.

KILN FUELS
PORTLAND CEMENT BURNED BY DIFFERENT FUELS IN 1923

	Number of Plants	Number of Kilns	Barrels of Cement	Per- centage of Total
Coal.....	101	641	108,272,858	78.7
Coal and oil.....	1	24	8,091,506	5.9
Coal and gas.....				
Oil and gas.....	2	9	16,313,410	11.9
Oil.....	18	95		
Coal, oil and gas.....	3	18		
Natural gas.....	1	6	4,782,464	3.5
	126	793	137,460,238	100.0

Preparation of coal for the kilns has led to the establishment of what are termed the coal grinding plants of the mills, the powdering of coal requiring drying, and pulverizing machinery of various types.

Crushing and Grinding Machinery

Increased efficiency in kilns was accompanied by equally essential improvements in crushing and grinding machinery. Progress in the development of kilns and crushing and grinding machinery was attended with competitive spirit rather than coordinated procedure. The crushing and grinding machinery first used to reduce raw materials and clinker soon failed to meet requirements both as to quantity and fineness.

While different works have different installations, in general practice the raw material goes to the powerful initial crushers and thence to the finer grinding machinery, some of which is used in the reduction of material both before and after burning. Some of these devices operate on the coffee mill principle and others reduce the material by attrition as distinguished from grinding. The latter include the tube mills, ball mills and kominuters. The tube mill is a revolving cylinder containing steel balls, steel slugs or flint pebbles. The ball mills are revolving drums containing steel balls. Material has also been crushed by revolving steel rolls.

An intermediate step between the burning and final reduction of the clinker into the powder called portland cement, is the cooling of the clinker, which comes from the kiln at very high temperatures. Sundry methods have been used to cool clinker. In many cases it is merely stored until needed for grinding. In earlier practice, clinker pits and rotary coolers were employed, followed by the upright clinker cooler which is still used at many works. The upright cooler is a steel cylinder about 35 feet high and 8 feet in diameter. The clinker enters at the top and descends over baffle plates and shelves. In its descent it comes in contact with air currents introduced by a perforated pipe running through the center of the cooler.

Packing and Weighing Cement

The grinding of the clinker is the last step in the manufacture of portland cement. The finished product is conveyed to the stock houses where it is placed in bins preparatory to weighing and packing. Except where intended for bulk shipment, cement is packed in barrels containing 376 pounds and in cloth bags or paper sacks containing 94 pounds, these being filled by packing machines. Rebates are given for the return of cloth sacks, and out of this practice arose complications and problems of the most vexatious nature.

The Cement Mill Power Plant

The heart of all the cement mill mechanism, which has been but briefly outlined, is the steam or electrical power plant and its auxiliary resources. From a mechanical standpoint the past twenty-seven years have witnessed many radical changes and in some cases complete revolution in practice.

In the crushing department we have seen small gyratory crushers replaced by huge ones of the same type. Mammoth jaw and giant roll crushers have likely replaced the small crushing units of similar types used in the early days. The introduction of the steam shovel is largely responsible for larger pieces of rock being handled and this in turn has produced economy in the number of men required to quarry raw materials.

H. A. Schaffer, long known in the field of cement manufacture as a chemical engineer and for a number of years past Conservation Engineer of the Portland Cement Association, contributes the following:

Persons familiar with driving machinery in cement mills from twenty to twenty-five years ago recognize little in the practices with which they were most familiar compared with practices today. Formerly all crushing and grinding machinery was driven from a common line shaft extending throughout the raw department. Each machine was connected to this main shaft by a belt driven pulley and was started and stopped by means of a friction clutch. These clutches were the bane of the cement operators' existence.

The machinery on the clinker side was driven in a similar manner from a main shaft connected to a large steam engine.

Today we find each and every unit throughout a modern cement plant directly connected either to an induction or synchronous motor, depending upon the size of the unit, wholly independent of every other piece of machinery in the plant.

The introduction of electrical drives has proved a great economy. It has greatly reduced necessity for repairs and renewals and in this way has contributed a most important part to continuous mill operation.

Referring briefly to the development of the waste heat boiler in the cement industry, Mr. Schaffer writes as follows:

The first attempt to utilize the heat of waste gases from rotary kilns was in 1898 at the works of the Nazareth Cement Company. Although this attempt

successful because of lack of provision for handling dust accumulations in the boiler, it nevertheless marked the initial effort of what has proved to be real saving of fuel in the industry.

The second installation, which was made at the plant of the Cayuga Cement Company, Portland Point, N. Y., was also abandoned after several years' operation, although a marked improvement was shown over the original waste heat boiler at Nazareth.

The third effort to generate steam from waste kiln heat was made at the Kosmos plant, Kosmosdale, Ky. This installation has been in operation for twenty years.

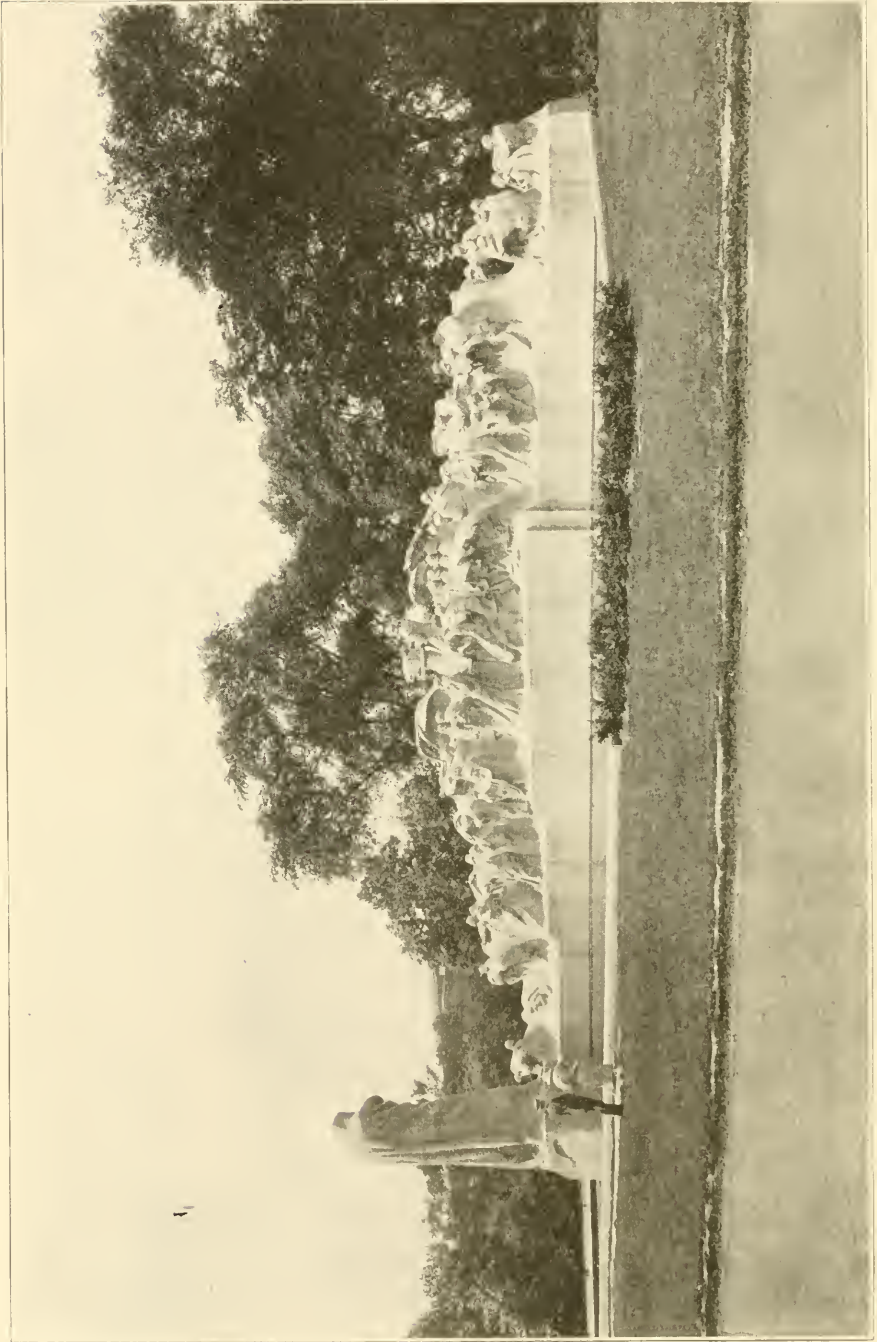
In late years many cement plants have been equipped with waste heat boilers. More will undoubtedly do so when the large financial outlay which such an installation requires can be justified. At the present time approximately forty different cement plants are developing from 50 to 100 per cent of their total power requirements from the heated gases which formerly were allowed to escape through the stacks into the atmosphere.

Classification of Portland Cement Production According to Raw Materials Used

A classification of portland cement production according to the raw materials used was made by the United States Geological Survey in 1914. The figures are interesting as showing changes in percentages of the different raw materials used from 1898 to 1914, the percentages being based on the total production of four classifications of portland cement material, namely, cement made from cement rock and pure limestone, that made from limestone and clay or shale, cement made from marl and clay, and that made from blast furnace slag and limestone. The figures are as follows:

Production, in barrels, and percentage of total output of portland cement in the United States, according to type of material used, 1898-1914.

Year	Type 1. Cement rock and pure limestone.		Type 2. Limestone and clay or shale.		Type 3. Marl and clay.		Type 4. Blast-furnace slag and limestone.	
	Quantity	Per- cent- age	Quantity	Per- cent- age	Quantity	Per- cent- age	Quantity	Per- cent- age
1898	2,764,694	74.9	365,408	9.9	562,092	15.2	.....	.....
1899	4,010,132	70.9	546,200	9.7	1,095,934	19.4	.....	.....
1900	5,960,739	70.3	1,034,041	12.2	1,454,797	17.1	32,443	0.4
1901	8,503,500	66.9	2,042,209	16.1	2,001,200	15.7	164,316	1.3
1902	10,953,178	63.6	3,738,303	21.7	2,220,453	12.9	318,710	1.8
1903	12,493,694	55.9	6,333,403	28.3	3,052,946	13.7	462,930	2.1
1904	15,173,391	57.2	7,526,323	28.4	3,332,873	12.6	473,294	1.8
1905	18,454,902	52.4	11,172,389	31.7	3,884,178	11.0	1,735,343	4.9
1906	23,896,951	51.4	16,532,212	35.6	3,958,201	8.5	2,076,000	4.5
1907	25,859,095	53.0	17,190,697	35.2	3,606,598	7.4	2,129,000	4.4
1908	20,678,693	40.6	23,047,707	45.0	2,811,212	5.5	4,535,300	8.9
1909	24,274,047	37.3	32,219,365	49.6	2,711,219	4.2	5,786,800	8.9
1910	26,520,911	34.6	39,720,320	51.9	3,307,220	4.3	7,001,500	9.2
1911	26,812,129	34.1	40,665,332	51.8	3,314,176	4.2	7,737,000	9.9
1912	24,712,780	30.0	44,607,776	54.1	2,467,368	3.0	10,650,172	12.9
1913	29,333,490	31.8	47,831,863	51.9	3,734,778	4.1	11,197,000	12.2
1914	24,907,047	28.2	50,168,813	56.9	4,038,310	4.6	9,116,000	10.3



"The Fountain of Time," on the Midway, Chicago, designed by Lorado Taft, world-famous artist, and executed in concrete by John J. Early, the noted architectural sculptor.

Progress in Mechanical Side of Industry Slow

It is needless to say that progress in the mechanical side of the industry in America was anything but plain sailing. In Europe labor was cheap and time was aplenty, and, as already described, it took many acres of settling "backs" and many months of preparation of the raw material before it was put in the kiln. In this country, Saylor, by the use of the wonderful raw materials found in the Lehigh district, which could be ground dry and mixed into brick with the minimum of water, was able, with enormous steam-heated drying floors, to dispense with much of the time and space required under European methods. Lesley, under patents of De-Smedt, Wilcox, and his own, supplied another means of economy in the direction above named. By these patents, which were in use for several years at the works of the American Cement Company at Egypt, liquid hydrocarbon (coal tars), was mixed with the raw cement material, which was then compressed in matched cells under high pressure into the form of eggs which, owing to their small size and their shape, were called "egg-ettes." The eggs were carried on conveyors to the top of the kilns where with the minimum of labor, they were charged with layers of coke prior to the burning process. In both cases the dried bricks of Saylor and the eggs of the Lesley process were put in layers with coke in intermittent bottle kilns modeled after those in use on the Thames and Medway in England. It took a great number of these kilns to make the few hundred barrels a day that were then produced in the respective plants, as the time of loading and burning consumed from eight to ten days, and the material, after burning, had to be carefully selected, so that neither overburned nor underburned material was fed to the crushers and mills.

These American processes, which did away with the settling "backs," the long period of evaporation and decantation which marked the European methods, enabled the material to reach the kiln in the minimum of time and with the minimum of labor. Then came the rotary kiln.

As stated by Mr. de Navarro, the first rotary kiln had many disadvantages, and the raw material used, being high in iron and magnesia, was not available for the production of portland cement. A. B. Bonneville, who in the eighties, had come from the plaster business into the Lehigh district and was operating a small mill there, was largely instrumental in inducing the Navarros, owners of the Mathey Process, to bring their plant into the Lehigh district, where portland cement material existed.

Difficulties Attending Initial Use of Rotary Kiln

Endless difficulties seemed to meet the attempt to establish the rotary kiln in the cement industry. The quality of the early cement did not recommend itself, and it was attacked on all sides by the American manufac-

turers who, following the practices of Europe, had established their brands in the highest engineering circles. The cement which was burned by oil was quick-setting in quality and presented difficulties in practical handling on the work.

While the Keystone Portland Cement Company was going through its trials and tribulations with the first kiln, Mr. de Navarro, who had been instrumental in building the elevated railways of New York and the great Navarro apartments in that city, and who, himself, had been recognized as a man of indomitable courage and enterprise, succeeded in interesting J. Rogers Maxwell, of the Central Railroad of New Jersey, a leading figure in Wall Street circles, in his enterprise. The story goes that a trainload of capitalists came up to look at the works, and while they were there the kiln was successfully revolved and good clinkers were burnt, but that just as the train was leaving after the inspection had been completed and capital had been satisfied, the kiln stopped, owing to mechanical difficulties, and all the old troubles were again in the works, while in the Wall Street district new prospects had been opened up by the investigating trip.

Contemporaneously with this development at Coplay by the de Navarro interests, Whittaker, the Philadelphia cotton manufacturer, with the cooperation of George E. Bartol, the Philadelphia capitalist, to whom reference has been made, had started a works near Phillipsburg, New Jersey, where rotary kilns were also installed.

Discovery of Retarding Influence of Gypsum in the Set of Cement

At this time the fuel used was oil, then selling around two cents a gallon. Both of these new concerns had difficulty at first in finding a market, for the reason above stated, the irregular time of setting of the cement being the determining influence. The de Navarro interests brought to their works as chemist, a French expert named Giron, who had found out in France that by mixing plaster with the water used in making cement sidewalks, the time of setting of the mortar was materially retarded, and he applied this knowledge to the manufacture of portland cement at the de Navarro works and succeeded in so regulating the time of setting of the rotary kiln cement, that it soon became recognized as a valuable material of construction. Whittaker, at Alpha, near Phillipsburg, followed in the same lines, and achieved equal success.

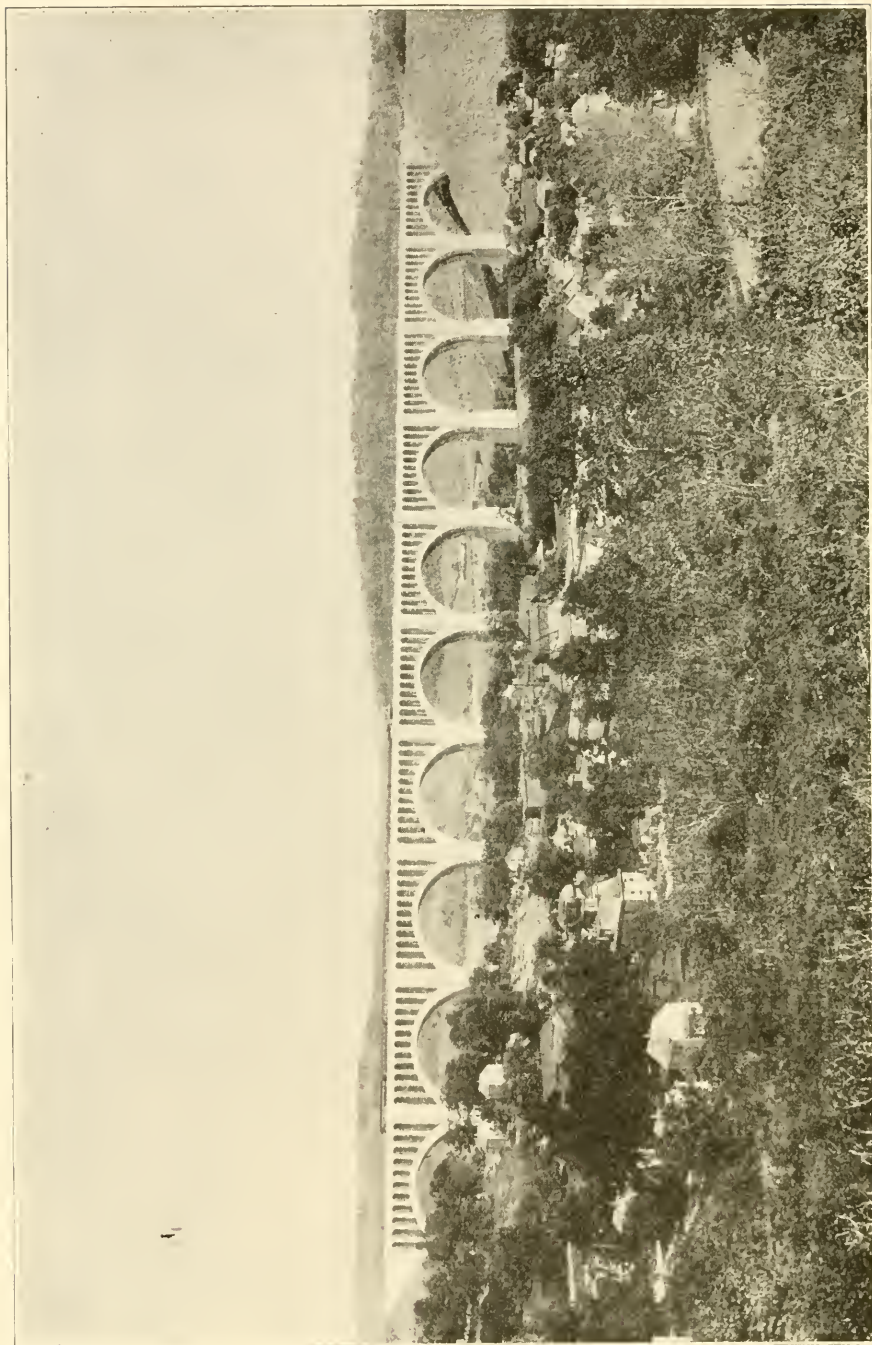
Giron's initials were P. I. and when he went to order his monthly commutation book by telephone from the station master at Coplay, the only thing the agent could make of his request was that a ticket was to be made out in the name of Mr. "Pig Iron."

Efforts to Reduce Fuel and Labor Costs Reveal Utility of Rotary Kiln

While this progress was being made with the rotary kiln, two developments were going on in the original Saylor's and American Cement Company's plants. After a trip to Europe by Saeger, the manager of the Coplay works, that company followed the European practice based upon cheap labor and high coal as against the American conditions of high labor and cheap coal, and installed a group of Schoefer continuous kilns, in place of their intermittent vertical kilns. At the American Cement Company's plant the process of using liquid hydrocarbon in making the little eggs was abandoned in the later eighties, the introduction of the Lowe water gas process having made coal far too expensive for use in cement making; and after going under the management of John W. Eckert, for many years associated with Saylor as chemist and superintendent, the American Company returned for a time to the process of brick making as used in the original Saylor process. This, however, did not continue long. Oil advanced rapidly in price and a few years later powdered coal superseded it in rotary kilns. The American Cement Company then threw its fortunes with the rotary kiln and built its first plant of 60-foot kilns of this type.

The rotary kiln proved exceptionally well adapted to American cement practice. Coal slack, which in the summer was made in the bituminous fields to the extent of many millions of tons, was available as pulverized fuel and could be bought as low as thirty and forty cents a ton at the mine. Coal was essentially cheap and labor had already advanced far beyond the cost of similar labor in Europe; consequently, as a historical fact, it may be stated that the rotary kiln, as an economical method of production, had its especial and distinct field in this country, which had cheap coal and dear labor, as against the opposite condition of high coal and cheap labor in Germany, England, France, and Belgium.

In the early days the small coffee-mill crushers with corrugated sides were constantly choking while digesting the raw rock broken by hand and shoveled into them. These constant breakdowns, tearing of belts, etc., added greatly to the cost of cement, and the American Cement Company was among the pioneers to substitute for these inefficient methods of crushing, the large type of Gates crushers which were able to take great pieces of rock, and deliver these in turn to the smaller coffee-mill crushers, which remained part of a gradual reduction process. Nor was this all that the American Cement Company, in the line of grinding and crushing, had to do with the industry. Up to 1886 or 1887 all grinding, both of natural and portland cements, had been done on old-fashioned buhr mills. Some of these were made of French buhr stone, and others of the Esopus stone found near the Rosendale district, in New York. To visit a cement mill



The largest concrete viaduct in the world—the Tunkhannock Viaduct, on the Lackawanna Railroad.

in these early days was to risk one's eyesight in the shower of flying bits of stone that active millstone dressers were constantly picking while sharpening the faces of the millstones. The merry clink of steel against stone made music in the mill, and the product, while fairly fine, was not sufficient in quantity as compared with the enormous cost of sharpening and renewing millstones.

Pioneer Work of John W. Eckert in Advancing Mechanical Side of Industry

To this side of the industry, embracing both crushing and grinding, the thought of John W. Eckert was devoted. Having adopted the Gates crusher for dealing with his large rocks in their raw condition, it was he who first introduced the iron mills of the Griffin type for pulverizing the finished clinker coming from the kilns in its very hard and crystalline condition. In company with Robert W. Lesley, he visited the works of the Bradley Fertilizer Company, at Wymouth, Massachusetts, where phosphate rocks were being ground in Griffin mills for the purpose of making fertilizers, and so impressed were he and his associates with the work done, that the first Griffin mill ever used on portland cement was ordered at once, and was later installed at Egypt, where it was in existence until four or five years ago.

To Mr. Eckert some improvements and patents involving modifications in the Griffin mill are due and to his foresight and perseverance we owe the iron mill in the cement industry. Whittaker, at Alpha, had heard of these mills, but he was not ready to put them in, and the story goes that he spent two days and two nights without sleep on the hills above the American Cement Company's mill at Egypt listening to the booming noise of the constantly revolving Griffin mill. When at the end of that time the mills were still rolling along merrily and he had heard no stoppage, he went home and put in his order for similar mills. Later on the de Navarro works, then under the name of the Atlas Portland Cement Company, introduced iron mills of the Narod type, and after a long litigation between the owners of the Narod and Griffin patents, which was carried to the higher courts, the validity of the later patent was sustained. Since that period there have been many other iron mills invented and introduced, such as the Kent, the Hardinge, Fuller, Sturtevant, and Frisbie. All portland cement today is either ground in mills of this type or in the later type of tube mills of Krupp, Allis-Chalmers, F. L. Smidth & Company, and other similar types. The old buhr stone is a thing of the past, as is the old vertical intermittent bottle kiln in which the first American portland cement was manufactured.

To the historian this constant race between the development of the rotary kiln and the iron mill presents many of the most interesting facts in

the development of the industry. The old cast iron crushers and mill-stones had not enabled the American manufacturer to grind his raw and finished product economically. The great change described above was one of two that had a marked effect in establishing the American industry and, followed as it was later in the development of these various types of machinery—in the introduction of tube mills, kominuters and similar apparatus—dispensed largely with labor.

While these great developments on the mill side were going on, equally important advances were made in the burning of portland cement. The old vertical intermittent dome kilns, used by Saylor and the American Cement Company, had a capacity of 150 to 200 barrels of cement every ten days, depending upon atmospheric conditions. The raw material, after drying, was loaded with intervening layers of coke until the kiln was filled. The torch was then applied and the fire was on. This mass of material gradually burned through, flames coming out of the top of the stack. In cooling off, the material contracted and the mass of clinker had to be dug out. It was loosened with bars and taken from the kiln. The yellow and the underburned and overburned material were selected by hand. The yield of these kilns was about 200 barrels every ten days, and in order to reach a production of 200 to 250 barrels of cement a day, it can be readily seen that a large number of kilns were required. Thus it was that in the early works of the Lehigh district, large rows of these intermittent vertical kilns were built, some of which stand today in dismantled state as monuments to the early cement manufacturers.

During the latter part of the decade 1880-1900, the first rotary kiln used in the portland cement industry was put into operation as described in Mr. de Navarro's account already given. This marked a critical and vital change in American methods, and, in fact, in cement manufacturing methods throughout the entire civilized world. Invented by Ransome in England and brought to this country by de Navarro, it was at first a failure, owing to the selection of the raw materials then used, and later on was again a failure owing to the character of the ground powder from the Lehigh rocks as first used in the rotary kiln. Undaunted, however, by these difficulties, the de Navarro interests courageously continued their operations until it was discovered that by the addition of gypsum in any form the quick-setting cement manufactured in the rotary kilns could be regulated and made slow setting.

The early story of the numerous experiments made at the old Keystone works in the nineties would almost fill a book, but the concluding chapter may be said to have been written when, through experiments in Germany and France, brought to this country through the instrumentality

of the de Navarro interests, the scientific regulation of the hitherto abnormally quick-setting cement produced from rotary kiln clinker was made possible.

The fuel problem was also of great interest. The producer gas used by Ransome lacked sufficient heat units to manufacture portland cement clinker successfully within reasonable time and at reasonable cost for fuel. The oil then being produced in large quantities in Ohio was available to manufacturers, who used this valuable fuel in an economical way in the early days of rotary kiln installation. This fuel, however, gradually advanced in price until the end of the nineties, when the cost became almost prohibitive, and new methods of dealing with the fuel problem were essential. It was at this time that Hurry and Seaman, the former an English mill engineer and the latter superintendent of the Atlas Cement Company, experimented with pulverized coal. Shortly thereafter the well-known Hurry and Seaman patent, which became the subject of so much litigation in the portland cement industry, was granted to the inventors.

Pulverized Coal Comes Into Use as Cement Mill Fuel

The use of pulverized coal solved the fuel problem for the rotary kiln, and made it what it has been for so many years, a mechanical success in the highest degree. As a labor saving device which enabled the manufacturer simply to grind his raw material and put it in the rotary kiln in either dry powder or wet slurry, according to whether the "dry" or "wet" process was used in the mill, the use of powdered coal was essentially an American device in labor saving utility. Man power was the great extravagance in which the American manufacturer could not afford to indulge. The milling and crushing machinery already described effected great economies as a substitute for man power, but it was the American method of using the rotary kiln which had dispensed with all handling of the raw material from the raw mills to the finishing mills, that became the capstone of the monument American ingenuity had reared in the manufacture of cement. The original rotary kilns were from 40 to 60 feet in length, and from 5 to 6 feet in diameter, and for a time kilns 80 to 100 feet long were considered the maximum size to which successful manufacturing could safely venture.

Thomas A. Edison First to Use Rotary Kiln of Greatly Increased Length

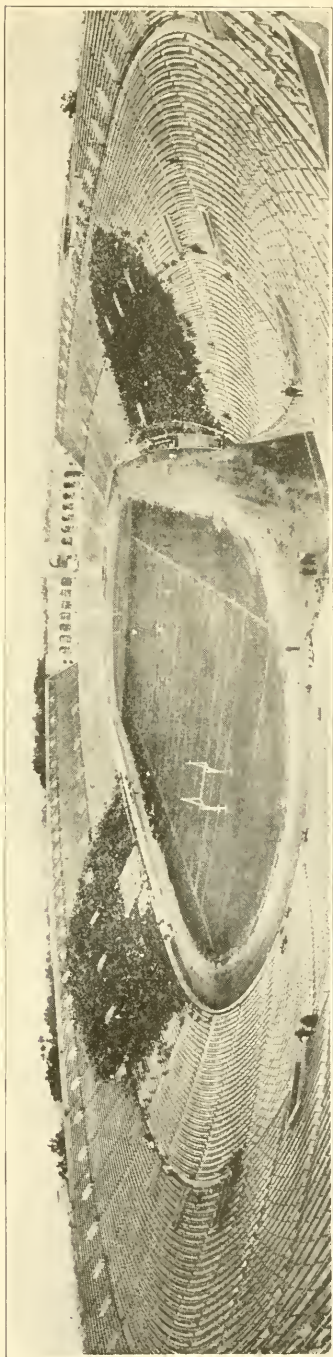
In 1909 Thomas A. Edison was granted a patent for the use of kilns 150 feet and longer, every one predicting that it would be impossible to turn kilns of this length without warping. The proof of the pudding, however, was in the eating, and it was not long after Edison's invention that kilns of 125 feet became almost standard as substitutes for the old 60-foot

kiln. Mr. Edison not only designed the long kiln described, but was the first to use steam shovels for loading rock in the quarries. He also introduced the well-drill in quarry operation. Later on the length of the Edison kiln was far exceeded. Some kilns now in use are 260 feet long, with capacities of a thousand or more barrels of cement per day.

Continuous Vertical Kiln Competing with Rotary Kiln

While this development of the rotary kiln was progressing in the Lehigh district, the old-time manufacturers there were still in a state of uncertainty. They had used intermittent vertical kilns successfully. They had banked upon following European practice in every detail as best calculated to give them a talking point to engineers when urging the adoption of the newly-created American product for the great engineering works of the period. Consequently a revolving kiln turning out clinker in hours as against days under old methods, struck them as something entirely irregular and improper. They could not believe in the final success of such methods, and when at about the same period Europe, especially Germany, began to use continuous vertical kilns of the Schoefer, Dietsch and similar types, the old-time American producer began to see that with which he could offset the progress the rotary kiln had begun to make, something he was used to, and which had behind it the authority of European practice. These kilns, 50 and 60 feet high, were fed continuously at the top with raw material in the form of bricks, blocks or other combinations of material, the latter drawn from time to time and the clinker taken to the finishing mills. The use of the raw material in this form was well known to the old manufacturers, and they believed that this type of kiln would be the one finally adopted. As a result, the Coplay Cement Company installed a number of kilns of the Schoefer type at their Coplay mill, which they operated successfully for many years, and the Glens Falls Cement Company, of which Captain W. W. Maclay was then President, installed ten Schoefer kilns between 1894 and 1899. Other installations were also under consideration, but the successful manufacture of portland cement with pulverized coal under the rotary kiln process was so marked as practically to terminate competition between the rival types of kilns, thus turning the entire American industry over to the rotary kiln which is now in use in every mill in the country.

In considering this victory of the rotary kiln in America, the fact must not be lost sight of that the old type of kiln used coke as fuel, and coke ruled at much higher prices than coal. In the early days of the rotary kiln, and up to a very recent period, enormous bodies of slack coal derived by the screening of run of mine coal to produce lump bituminous coal, existed in many parts of the United States. This was sold at such a low price as



The Coliseum at Los Angeles, seating 75,000 people, is one of the largest concrete stadia in the world.

to make the calcining operation in portland cement mills using the rotary process not only economical in labor as compared with European countries, but also far more economical in fuel than ordinary comparative figures between the market sizes of bituminous coal in this country and in Europe would seem to indicate.

Old methods in mill practice gave way in the American industry to new and improved machinery, in many cases of American invention and design. The calcining operation in portland cement was revolutionized by the American adoption of the rotary kiln. The progressive war in American cement mills has been that of constant improvement in each of these two wonderful fields of development. The old fleets of carts and wheelbarrows that conveyed rock from the quarry to the mill have been supplanted by the steam shovels and trains of cars, the latter carrying the rock to enormous crushing plants, where giant crushers, handling hundreds of tons of raw rock per hour, prepare it for storage in great silos, where it is carried to one or more mills located in the vicinity and tributary to the quarry itself.

Some of Those Who Contributed to Mechanical Advancement

Many types of milling machinery have been devised since the industry began, and many of the earlier types have grown from small mills to enormous apparatus with great capacity. The history of the Griffin mill has been that of steady growth in size and capacity. The Fuller mill has a history of equal interest, while the Kent mill, the Williams hammer mill, and the Hardinge mill are all cited as types of the big development in this field of cement manufacture.

The tube mill was another important factor introduced through the great Danish firm of F. L. Smidth & Company. This firm kept constantly abreast of the times in its various forms of tube mills, kominuters, ball mills, etc., and German and American improvements in the same line have so developed this form of grinding machinery that some of the modern mills require as much as 400 h. p. to turn them in order that they may produce the greatly increased capacity now demanded of all American machinery.

In considering the subject as a whole, there is forced upon one the conclusion that without these discoveries the world, in its great demand for cement for all of the numerous uses for which it is now accepted, might have been much longer in attaining its object. Had the developments on these two sides of this great industry not proceeded as they did in parallel lines, and at practically the same time, there never would have been the present enormous production of portland cement. The manufacturers did well their part in providing energy and capital for all this great develop-

ment, but it must not be forgotten that such engineers as Frederick H. Lewis, Lathbury & Spackman, the Hunt Engineering Company, F. L. Smidth & Company, and other prominent engineering firms, also contributed greatly to the successful work. If all the improvements in the grinding and crushing side of the industry had been made and the old crackers and buhr mills discarded without a new form of calcining apparatus, the enormous amount of material these forms of improved crushing and grinding apparatus produced would have been far in excess of the capacity of kilns of the old vertical type. On the other hand, had the rotary kiln been developed to its full extent without the improved crushing and grinding machinery, there never would have been sufficient material to meet its great capacity. Thus it was fortunate that contemporaneous with the introduction of the rotary kiln and keeping pace with its commercial establishment, there was the great development in crushing and grinding machinery.

Typical Example of Progress in the Mechanical Side of the Industry

This chapter might well conclude with the story of the Glens Falls Portland Cement Company's founding and development as told by Mr. Bayle, for as stated previously, the experience of that company was typical of the period that witnessed the discarding of the vertical intermittent kilns for those of the rotary type as well as changes in crushing and grinding machinery. Mr. Bayle says:

For some years previous to and during the time of the Civil War, and continuing in a lesser degree to the present day, one of the important industries of Glens Falls was the production of lime, made from an extensive deposit of black marble, which underlaid strata of clay and inferior lime rock locally known as "buckwheat." These upper strata varied in thickness of from 4 to 15 feet. About 1885 the Jointa Lime Company contemplated the manufacture of brick from this clay deposit, and in its search for proper machinery, fell in with an intelligent Scotchman who had worked in cement plants in the old country. He had been making some experiments with the product at Howes Cave, New York, with minor success and was employed to experiment with the limestone and clay at Glens Falls.

After somewhat more extended investigation the Glens Falls Portland Cement Company was organized early in 1893 with a capital of \$48,000, estimated as sufficient to erect a plant capable of profitable production of 100 barrels a day. This plant was completed during 1893. It was a well-built plant but had several mechanical and scientific defects; for instance, the clay dryer would not dry the clay, the mill could not reduce the rock, and the kiln could not produce the clinker. Were a cement expert of the present day to investigate it without a guide, he would wonder what it was intended to produce. No indication of discouragement existed among the projectors of the enterprise. Cement had been produced from the raw materials and a commercial article was possible through intelligent persistence. They had nearly absorbed their capital without results, and early in 1894 the capital was increased to \$72,000. Two Schoefer kilns were erected and machinery was installed to prepare the materials and reduce the clinker. The problem of maintaining the uniform product was worked out to some extent.

The first few barrels of cement produced set as hard as the sides of an iron clad the moment they came near water. The Federation of Labor in those days had not instructed its members in the matter of efficiency and rapidity of motion to a sufficient extent to make the product of commercial value. A few barrels were finally produced called "slow setting," and one of the prominent stockholders was induced to lay a new cellar floor on his property. It is said that the floor is still in existence and holds the finger prints of a majority of the then stockholders.

About this time the bank of the Champlain Canal adjoining the works gave way, washing out many foundations and depositing materials of much value into the Hudson River. It may be stated that this unauthorized watering of the stock was the only incident of its kind in the financial history of the company.

In 1895 four more Schoefer kilns were erected, and the necessary machinery installed. The reliability of the product began to be recognized in the trade. The capital was again increased, from \$72,000 to \$200,000, each increase in capital being absorbed by the stockholders taking their pro-rata share. The year failed to close without a discouraging incident. The 600 h.p. engine evidently concluded the plant was not working up to capacity, and took matters in its own hands. It raced up beyond its endurance and threw its 18-foot fly-wheel through the mill and to the heavens above. Fortunately the only casualty recorded was the seat from the trousers of the engineer.

In 1899 four new Schoefer kilns were added to the six already in use, but before they were put into commission the entire plant was destroyed by fire, leaving only the ten kilns standing. As these were the only remaining asset, and the rotary kilns had not then developed their present admitted superiority, the plant was rebuilt by July, 1900, with the old kilns as a nucleus. The principal advances made at the time of rebuilding included the installation of tunnels for drying the raw mixture bricks with waste heat gases from the power plant, and the addition of clay to limestone by automatic scales when each material had been crushed to one-half inch, and the combined material pulverized in a Griffin mill to a complete raw mixture. This change seems simple enough today, but from the establishment of the plant these materials had been pulverized separately and then mixed together in the proper proportions by batches in a rotating cylinder, and the change seemed quite revolutionary. Also, advantage was taken of the opportunity during reconstruction, to separate the raw and clinker departments, providing separate steam power units and routing material in the direction of the successive steps of manufacture.

The ten stationary Schoefer kilns were then producing about 600 to 700 barrels per day, as an average of one kiln was out of commission for relining at all times. About 1902 induced draft was applied to these kilns by means of a fan system at the tops, and three shifts of burners instead of two were employed to increase the number of "draws." This increased the capacity to about 1,000 barrels per day.

In order to decrease the loss of waste clinker caused by uneven burning, an old ball mill was loaded with it and rotated until the hard burned pellets of clinker pulverized the softer under-burned pieces which passed out through screens, and the retained hard burned part added to the good clinker. This mixture of "fines" (amounting sometimes to 10 per cent of the output) containing much hard burned clinker, had been previously thrown away. About the same time 5 per cent soft coal was added to the raw mix in the Griffin mills to improve the uniformity of burning in the kilns and promote the soundness of the clinker, but without effect, although it made a better raw mix brick, which was more resistant to crushing in the kiln.

About 1906 a deposit of cement rock was discovered and opened on the Saratoga County side of the Hudson River at about the same time that the initial pair of rotary kilns was being installed in hope of reducing labor costs. The use of this material reduced

the amount of clay required, but compelled the addition of more efficient drying equipment for the stone, which carried more water than the 90 per cent "buckwheat" limestone in use before. These changes permitted the abandonment of the clay storage and dryer outfit previously operated, and the entire raw product was then passed through the raw mill crushers, greatly simplifying the raw grinding.

When the first two rotary kilns were started up it was found that the same raw mixture, whether of limestone and clay, or plain cement rock, would not give a cement passing the boiling test in the rotary kiln, while it would in the Schoefers. As the obvious economy of rotary kilns compelled their continued use, the problem was attacked in the direction of a better raw mix fineness for the rotary kilns. A tube mill was added for the purpose of increasing the fineness of the raw material being furnished to the rotaries, and an increase of 5 to 6 per cent on the 200-mesh sieve produced a fairly consistent boiling test from the rotary clinker, and demonstrated that a mix being clinkered in 20 to 30 minutes would require a greater fineness to undergo complete reaction than one kept at red heat for many hours, as in the Schoefer kiln.

As soon as the economic success of the combination of cement rock for raw material and rotary kilns for burning was proved, the entire Schoefer plant was discarded and two more rotary kilns of slightly larger diameter were purchased. At the same time the substitution of kominuters for ball mills enabled the company to reduce their raw grinding plant to the simple modern units of crusher, dryer, kominuter, and tube mill, turning out a raw mixture of 90 per cent through the 200 sieve.

In the early period of rotary burning it was found that the variations in the composition of the cement rock raw mix were too great to produce a uniform cement. On account of the large amount of material in the Schoefer kiln in proportion to the output, variations of 3 to 5 per cent in lime carbonate had not been prohibitive, especially as the quality of the cement was largely dependent upon the burning which, while good on the average, could not be closely controlled.

In the rotary kiln a small stream of material passing rapidly through the kiln showed these variations to such an extent as to reduce the capacity of the kiln and threaten the quality of the output. As a remedy the automatic scale system was removed and six bins were placed between the kominuters and tube mills, and their contents after analysis while filling, were blended with succeeding bins in proportion to their variation from correct composition by means of variable speed worm conveyors. The accumulation of too many high or low bins was prevented by addition of either high calcium limestone or clay at the crushers, as indicated by the composition of the bins already on hand. The additional cost of this system is considered compensated for by the extra storage capacity it affords, and the increased output of the kilns with uniform raw mixture.

CHAPTER X

COMMERCIAL DEVELOPMENT OF THE INDUSTRY

Pioneers in the Field of Cement Salesmanship

To establish a new product in a market where its use in great buildings and engineering works involved great responsibility to the architect and engineer was no easy task. The difference in cost between imported and domestic cements was so slight in proportion to the total cost of any building project as to make the change from the well-known foreign to the domestic cement a matter of slight financial interest. Consequently, the early days of the industry also brought forth brilliant salesmen. They were hard fighters, always having the affirmative of the question, always having to lead the attack upon an established product. It was due to the tact and intelligence of these men in their contact with engineers and the convincing arguments they presented, that the commercial growth of American portland cement forged ahead.

To Johnson & Wilson, the representatives of Saylor's cement in New York and in most of the Western country, the use of that brand upon the Eads jetties at New Orleans, upon the great works of the Lackawanna Steel Company at Scranton, and upon other monumental engineering works in the country was directly and distinctly due. It was through their able presentation of the cause of the American portland cement manufacturer, that American portland cement began to receive favorable consideration at the hands of the American engineer.

The firm of Lesley & Trinkle, which had been large importers of foreign portland cement, and which was also associated with David O. Saylor in the introduction of "Saylor's Portland Cement," and later on in the introduction of the "Giant Portland Cement" of the American Cement Company, did similar work. It was due possibly to the work of Robert W. Lesley, who was the senior partner of the last-named firm, and later President of the American Cement Company, that the engineering world became better acquainted with the qualities of American portland cement. Lesley's papers presented at various meetings of engineering societies, his association with the very beginning of the industry as well as with leading engineers, and his membership in many of the engineering associations, enabled him, both in public discussion and private argument, to convince engineers and scientists of the value of the American product. An argu-

ment presented by him to Alphonse Ftely, Chief Engineer of the Croton Aqueduct Board, was the means whereby the use of American portland cement was permitted to be used "under closest scrutiny" in that important engineering work to the extent of millions of barrels when the original specification called for "imported portland cement." A



A beautiful example of portland cement stucco over concrete, at Los Angeles.

similar argument presented to the engineers of the Third Avenue Railway, in New York, secured the adoption of American portland cement in the conduits of that line, while by personal argument the engineers of the Metropolitan Street Railway were likewise persuaded to use the American product.

Hiram Snyder, of New York, an old Rosendale man, James Davis, of Boston, Donaldson of Philadelphia, were all salesmen of wonderful ability and talent in presenting the case of the American portland cement manufacturer. By degrees the American cause found equally able advocates in the West, and by the selling qualities and force of character and the ingenious arguments of these men, American portland cement may be said to have been put upon the map.

To mention the progressive and able engineers who listened to these arguments and who, after investigation, were convinced of their value and gave effect to their weight by permitting the domestic article to be used in lieu of the foreign, would be to name a list of all great engineers who were foremost in the field of engineering construction at the time. Among them were Alphonse Ftely, Chas. S. Gowan, Robert Ridgway, Alfred

Craven, George S. Rice, Jr., of the New York Croton Aqueduct and later one of the New York Aqueduct Board; William N. Brown and Joseph T. Richards, of the Pennsylvania Railroad; A. Katte, of the New York Central Railroad; Alfred P. Boller and Thomas Curtis Clarke, the great bridge engineers; George B. Burbank, the engineer of the first Niagara tunnel; Eads, the builder of the Mississippi jetties; William W. Scranton, the builder of the Lackawanna Steel Works; Andrew Carnegie, of the great steel works in Pittsburgh; Joseph M. Wilson of Philadelphia; George S. Webster, of the Philadelphia Bureau of Surveys; William M. Marple, of the Scranton Water Works; and Frederick Pike Stearns and Thomas E. Richardson of the Metropolitan Water Board of Boston.

Whole books could be written on the difficulties of the early pioneers in the field of cement salesmanship, of the continuous butting of heads against the stone wall of established practice and prejudice, of the days and nights spent in assiduous personal solicitation of customers, of the personal visits to important engineering works, and the supervision of concrete mixing and testing of briquettes to satisfy both the technical and practical minds in charge of the work. Interesting stories could be told of personal guarantees given by many of these men to introduce their product, and how, day in and day out, for better or for worse, in times of car shortage, in times of coal shortage, in times of delay in manufacturing, they kept the work going and kept quality up to the highest standard.

Too much cannot be said in praise of these men and their work. To them the brand they sold was a fetish; its reputation was to be guarded like that of Caesar's wife. No task was too great, no labor too severe to maintain the reputation and the trade they had built up.

The Favor Accorded a Brand Name

In these early days the brand was the thing. Testing was in its early stages. The dead level of many brands of equal quality had not been reached, for the manufacturers were few and each fought bitterly to maintain his own standard and his own brand.

People Did Not Believe Good Portland Cement Could Be Made in Rotary Kiln

In the period following the introduction of the rotary kiln, the "War of the Roses" was nothing to the battle waged between those who were the advocates of the "substantial, well-established old methods of Europe" against the "new-fangled abomination of cement made in rotary kilns." The clever salesmen, in many cases members of engineering clubs and engineering societies, were constantly called upon to read papers or make arguments before crowded meetings on this important subject, and it got

to be a well-known fact in engineering circles that whenever a crowded meeting was required and interest was to be awakened, a discussion between representatives of vertical kilns and rotary kilns in the cement industry would draw full houses. In those days it was doubtful whether a great prize fight aroused more public interest than the fight between representatives of these two sides of the cement industry. This work, however, was all propaganda of the highest degree. It centered the attention of engineers of the country upon the growth of a great and valuable industry. It set many to thinking of the potential worth of this plastic material, and of the great field which it was destined to fill; and while, in a general way, wishing "plague on both your houses," the engineers ceased thinking in terms of foreign portland cement in favor of the American or home-made article.

Early American Portland Cement Often Condemned Without Reason

Those days were filled with the sad tales of "condemned" cement, a word with which all the old manufacturers were thoroughly familiar. While in many cases any old foreign portland cement would go through on its brand, American cement was always received, as described in the words of Alphonse Ftely, Chief Engineer of the Croton Aqueduct Board, "with strictest scrutiny." For this reason the slightest defect in time of setting, fineness, color or any other slight deviation, would be sufficient excuse to turn the cement down, a situation requiring the immediate attention of the higher officials of the company, who, in those days, were what were known to engineers as "cement doctors."

It was no boy's job to maintain the sacred reputation of American portland cement. Owing to the fact that the earliest works first commercially successful were located in the Lehigh district, it was there that the principal portland cement testing laboratories made their appearance. In Philadelphia many cement securities were owned, and two engineering firms in that city, Booth, Garrett & Blair, and Lathbury & Spackman, were prominent figures in both testing and engineering in connection with early cement. It was generally to their laboratories that disputed questions were referred for final test and arbitration. In New York, Dr. McKenna had entered the field with his chemical laboratory, and in Boston, Eliot C. Clark, of the Metropolitan Sewerage Department, had also become an authority, while Maclay's work in the New York Dock Board had made him an arbiter of cement quality.

In reminiscences contributed by Frederick H. Lewis, much interesting information is given as to the connection of the firm of Booth, Garrett & Blair with the cement industry, and also of Mr. Lewis' own experience. His first interest in portland cement as a material of construction began in

1890, in which year American production of portland cement amounted to 335,000 barrels. The domestic cement was getting a foothold, though, as Mr. Lewis states, engineers continued to specify some brands of imported portland cement. As the laboratory of Booth, Garrett & Blair, Philadelphia, had for years been identified with another Pennsylvania industry, the chemical analysis and physical testing of iron and steel, it was but natural that the American portland cement manufacturers in the vicinity of Philadelphia should, when in trouble, seek the assistance of this well-known firm. Many were the days when those who were upbuilders of American portland cement spent hours in the old laboratory on Locust Street making cement pats, supervising the making of briquettes and then testing, thus endeavoring to overcome through the arbitration of engineers the complaints made by contractors and others unfamiliar with the advance in cement making in this country. It is true, as Mr. Lewis says, that American technology in portland cement was quite limited in scope and rudimentary in quality throughout the period between 1880 and 1892, and aside from Eckert, who was a trained chemist then superintending manufacture by the American Cement Company, and Pierre Giron, the Belgian engineer who later went into the employ of the Atlas Company, there were few, if any, cement workers whose knowledge corresponded to the well-known "technikers" usually in charge of the German cement works, at that time the most scientifically successful in the world. Lewis went to Europe in 1892, visiting representative laboratories and hunting up cement technology. "I returned," he says, "convinced that portland cement in America represented a great business opportunity, and on the technical side I was very keenly interested in the experiments and the theories of Le Chatelier and Candlot, the French experts whose writings were then, and I think are still, the best technical treatises on portland cement." This visit put the Booth, Garrett & Blair firm, with which Mr. Lewis was associated, far ahead in the field of scientific testing and handling of both American and foreign portland cements. Mr. Lewis says:

Mr. Whitfield did the chemical work and I did the physical testing, and our senior partner, Andrew A. Blair, cordially cooperated with both of us. Every American and every European brand to be found in America came under our scrutiny. We had put in a lot of special grinding machinery and built laboratory kilns, in which we burned many batches of cement clinker, using a few pounds at a time. We ground each lot into cement for experimental purposes. There was no phase of the portland cement problem which did not receive our attention between 1893 and 1897, and during that time I acquired an intimate personal acquaintance with American cement plants, both natural and portland.

In 1897, Mr. Lewis went to Europe again, visiting cement plants in England, Belgium, Germany and France, as well as the great laboratories abroad, bringing back much information and many technical books. He was essentially one of the men upon whom American manufacturers leaned

during the formative period between 1890 and 1900. He was among the first to test and realize the value of rotary kiln cement, and had much to do with giving it a standing among engineers at the time the bitter war of the old companies was being waged upon this new product. As Lewis says in summing up the discovery of the rotary process and his investigations in Europe:

Europe had cheap labor and expensive coal; America paid wages from two to four times that of Europe, but bought coal for half the European prices. The short kilns or the ring ovens in England and Germany were quite economical in fuel, much more economical than could be expected of a rotary kiln, but required far more labor than an American could afford. If, therefore, good cement clinker could be produced in a continuous rotary kiln at any reasonable cost, then an American portland cement industry was assured. The preparation of material for the rotary kiln, the handling of the clinker from such kilns, and the handling of the kilns themselves, could all be done with very low unit cost for labor.

It was with these thoughts in mind that Mr. Lewis, while progressive and fair to all the manufacturers of the old type of cement, was inclined to believe in the new type and from that point of view engaged in exhaustive study of rotary kiln cement.

The Firm of Lathbury and Spackman

Another firm, that of Lathbury & Spackman, composed of B. B. Lathbury and Henry S. Spackman, both engineers of distinction, had also become established in Philadelphia, and like Booth, Garrett & Blair, were constantly consulted as experts. They, too, had numerous clients among the Pennsylvania manufacturers, and their reputation as cement experts spread far and wide, just as Maclay's contribution to the literature of cement had made him an arbiter in New York, and Clarke's work had given him distinction in Boston.

The firm of Lathbury & Spackman, subsequently the Henry S. Spackman Engineering Company, was one of the first to enter the cement industry. Mr. Lathbury had established a laboratory in Philadelphia for the inspection and testing of cement and other engineering materials in 1895. He was employed by the architects of the Philadelphia Bourse Building to inspect the cement used in its construction, and in this way became interested in the subject of portland cement generally. This work made it necessary for him to study the manufacture of cement at the mill and he became familiar with that side of the industry. While conducting experiments and tests he demonstrated the practicability and economy of powdered coal as fuel in rotary kilns.

In 1897, Henry S. Spackman became a member of the firm which opened offices and laboratories on Filbert Street, Philadelphia. Shortly after, the Alpha Cement Company, at whose plant Mr. Lathbury had

gained his early experience, was unable to supply cement to its Pittsburgh agents. They decided to construct a mill of their own near the marl beds at Castalia, Ohio. In looking for engineers competent to build the mill, the firm of Lathbury & Spackman was recommended, the sponsor stating that there was only one firm, to his knowledge, who knew anything at all about cement manufacture and that "they knew damned little," this flattering



This dream city is a portion of the setting and courtyard for Douglas Fairbanks' photoplay, "The Thief of Bagdad." Both the courtyard and the buildings are of concrete.

recommendation referring to Lathbury & Spackman. They were engaged to build the Castalia plant and to superintend the erection and first operation of the mill, manufacture beginning in the spring of 1898. The usual difficulties were encountered and in course of time it was found that certain mechanical appliances did not have sufficient capacity to meet requirements.

First Mill Built for Burning Powdered Coal in Kiln

To Lathbury & Spackman has been given the credit of designing the first mill equipped specifically for burning powdered coal as fuel in the rotary kiln, although it was a close race between them and Matcham, who left the Alpha Company to design and build the first mill of the Lehigh Portland Cement Company. Matcham, however, did not commence his plans for this mill until some time after work on plans of the Castalia plant had started. It is interesting in this connection to note the marked

difference between the cost of machinery installed in the early mills and that now in use. The mill of the Castalia Company cost, ready to operate, exclusive of ground, less than \$125,000.

The success attending the construction of the Castalia plant led to the retention of Lathbury & Spackman by a number of companies during 1898 and 1899. During this period they built mills in Pennsylvania, Ohio, Utah, and Michigan, and were employed by manufacturers abroad, designing and constructing important plants in Denmark, Canada and England.

Having entered the cement industry with minds trained along engineering and chemical lines, and without being hampered by old traditions and preconceived opinions or the precedents so venerated by those brought up in the cement industry, the work of the firm was accompanied by many innovations and improvements, marking wide divergence from standard practice. Today these have become standard in mill construction, but their early adoption required courage and the spirit of the pioneer. In addition to bringing into general use powdered coal as fuel, they may be credited with the first successful installations of rotary kilns in Europe. It is said that they were the first to use electric power transmission, which was introduced in the Alma Portland Cement Company plant and the Utah Portland Cement Company plant. They were the first to manufacture portland cement from blast-furnace slag and limestone, which occurred at the Clinton Cement Company plant in Pittsburgh in 1898, and the first to use limestone and clay by the dry process in rotary kilns, which occurred the same year. Lathbury & Spackman were again pioneers in the use of waste from the alkali industry, and the first to install rotary kilns for lime burning, which took place between 1902 and 1904.

Enlarging the Field in Cement Mill Construction

Upon Mr. Lathbury's retirement in 1904, Mr. Spackman continued the business under the name of Henry S. Spackman Engineering Company, greatly enlarging his field, especially the business of inspection and testing. The firm has built approximately twenty large and important mills, located in all parts of the world. In the United States they designed and constructed plants in Ohio, New York, Pennsylvania, Michigan, Indiana, North Dakota, Maine and California; while their foreign work included plants in Germany, New Zealand, Cuba and Mexico. They were also retained to make examinations and reports on cement properties, these comprising some fifteen localities throughout the United States, two in England, one in Canada, and one in France.

Mr. Spackman is the author of many valuable papers relating to cement and concrete, having been a contributor in this field for years. His chemical and physical research covers the testing and use of cement

as well as its manufacture. He has taken an active part in the work of Committee C-1 of the American Society for Testing Materials since its formation.

In referring to all this testing of cement as part of the commercial development of the industry, it must be understood that there was required just such work as was done by testing laboratories of established reputation before the American cement could acquire merited standing.

In those days there were no definite specifications, though there were standard methods for the testing of cement adopted by the American Society of Civil Engineers in 1885, these accompanied by suggestions as to possible requirements. With this door open and in dealing with a new material, it was common practice for nearly every engineer to make his own specifications, and consequently "condemned" cement was not, in many cases, so much a matter of careless manufacture as varying specifications.

In looking at trade conditions and the general growth of the industry from a retrospective point of view, it may well be said that for many years the commercial or selling side of the industry was just as important as the mechanical or manufacturing side. In those days knowledge of the subject and personal equation counted heavily and the man fitted by these to make sales in large quantities at good prices was a factor of the greatest value to a newly established company, his capabilities having as much to do with successful results as did the iron and steel fashioned into the important mechanical devices that produced the cement.

Captains of Industry Begin to Appear in Cement Manufacturing

As time went on, what may be termed the second formation in the industry arrived. New conditions supplanted those attending the work of the pioneers from 1880 to 1900. The selling side began to shrink into a position of secondary importance. This was because portland cement was becoming a staple article of commerce carried by dealers all over the country, who distributed it in large and small quantities to customers. Therefore, in many cases, the great arguments that had been addressed by skilled salesmen and the engineering type of vendors to trained engineers, ceased to have their former powerful influence and effect. The material was better known, had a standing of its own, and through established dealers was beginning to find a market everywhere. So it was that when the second period marking the organization of captains of industry who began to operate and own cement works of great capacity between 1900 and 1910 was reached, machinery of great capacity, great quarries, great facilities, began to occupy their minds in a fuller degree than the salesmanship which, in the earlier days, had been so instrumental in

building up the industry. This is said in full realization of the fact that with greatly increased output of cement, salesmanship is as important now as it ever was, and that it is never to be belittled in any great industry. The purpose is to make clear the distinction between modern salesmanship and that of early years when salesmen fought like the single warriors of ancient Rome or the feudal period as distinguished from the thoroughly officered and fully equipped great army engaged in fighting the battles of the world in this day.

CHAPTER XI

THE SCIENTIFIC SIDE

To understand and appreciate the enormous importance and development of the scientific side of the portland cement industry one must turn back to the period when the early manufacturers began their work so as to realize conditions that pertained to the testing and use of cement.

Scientific Studies Handicapped by Lack of Literature

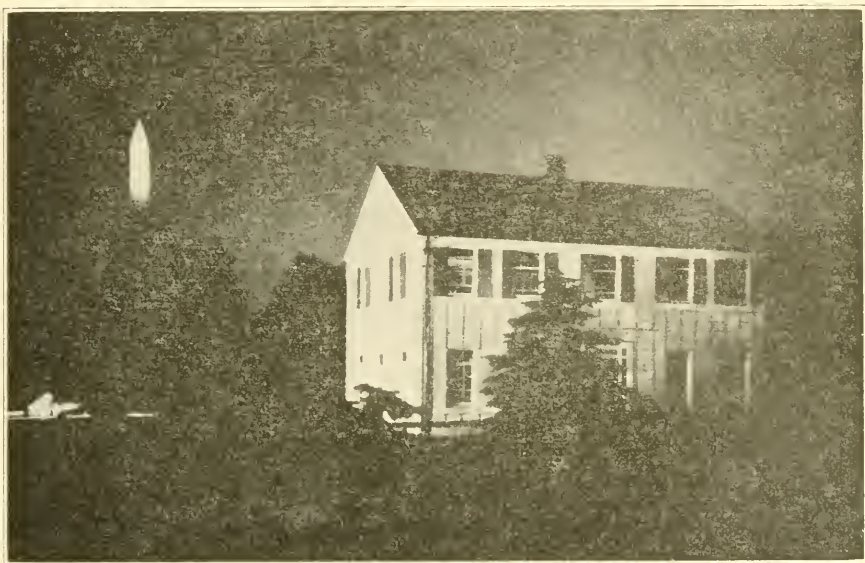
There was little or no literature on the manufacture or use of portland cement. American scientific papers contained little reference to this material, and when the American manufacturer would scan the French, German and English engineering papers he was seldom rewarded for his efforts. A paragraph now and then was a great prize and highly valued. Some few writers in Germany and England had begun to contribute their experience, and while distinguished engineers in the latter country had written papers on the use of portland cement and had read them before the British Institute of Engineers, there was very little literature in this country relating to the material. Hardly anything was known of the many uses to which cement is now adapted or employed. It is necessary to visualize a practically clear and untraveled field. There were no paths nor even foot-prints to guide the American manufacturer of cement or the American producer of concrete in any of its forms.

These were the days of the late seventies and the early eighties, and specifications were rare. The quality and methods for testing cement had just begun to be understood and to take some definite shape. Among the earliest tests of portland cement in the United States were those made by Eliot C. Clarke, in charge of the Boston Main Drainage Works, who, in his report covering the period from 1878 to 1884, gave the following figures as his results of tests of portland cement, practically all of it foreign brands:

Neat Cement	1 day	1 week	1 month	6 months	12 months
Portland Cement	102	303	412	468	494
With Sand					
Portland Cement		160	225	347	387

Preliminary Report of Committee on Uniform Tests

It was just about that time that the American Society of Civil Engineers received at its annual meeting on January 16, 1884, the preliminary report of its Committee on Uniform System for Tests of Cement. The members of the committee submitting the above report were: Q. A. Gill-



A modernized adaptation of the house that inspired John Howard Payne to write "Home, Sweet Home." Built on the White House grounds by the Better Homes Movement, the house is now occupied by the Girl Scouts.

more, D. J. Whittemore, J. Herbert Shedd, Eliot C. Clarke, Alfred Noble, F. O. Norton, and W. W. Maclay. In commenting upon the report, Mr. Whittemore stated:

The relative importance of the two cements, the American hydraulic cement and the portland cement, might well be brought out at this meeting. I am placed in a position to assert pretty confidently that the amount of American (natural) hydraulic cement annually used in this country this side of Buffalo is nearly 2,000,000 barrels; that made on the other side amounts to about 1,250,000 barrels a year. The amount of portland cement used in this country is, as you know, very much less than that; that is to say, perhaps half a million barrels would cover the entire annual consumption of portland cement on this continent at the present time. So when we are devising methods for testing cement we want to bear in mind what a very large proportion of the cement used is the product of our own country.

The following year, on January 21, 1885, the committee, to which had been added Leonard F. Beckwith and Thomas C. McCollom, submitted its report which dealt practically with methods of testing and not with

actual specifications for portland cement. In the report the committee started with the truism, "The testing of cement is not so simple a process as it is sometimes thought to be," and then gave methods by which cements of both natural and portland types should be tested, and at one point it inserted a table, "showing the average minimum and maximum tensile strength per square inch which some good cements have attained under the conditions specified elsewhere in this report."

American and foreign portland cements, neat: 1 day, 1 hour, or until set, in air, the rest of the 24 hours in water, from 11 pounds to 140 pounds.

1 week, 1 day in air, 6 days in water, from 250 pounds to 550 pounds.

1 month (28 days), 1 day in air, 27 days in water, from 350 pounds to 700 pounds.

1 year, 1 day in air, the remainder in water, from 450 pounds to 800 pounds.

It will be noted that there is a wide margin in these requirements and that in a way the figures compare with those given above as being obtained by Mr. Clarke, of the Boston Sewerage System.

In dealing with the question of sampling, the committee again illustrates the condition of the art of testing by stating:

There is no uniformity of practice among engineers as to sampling of the cement to be tested, some testing every tenth barrel, others every fifth and others still every barrel delivered.

The committee went on to say, however, that the "testing of every fifth barrel would answer for ordinary work where the cement had a good reputation, but in important construction where strength might be affected by a particular barrel, each should be tested."

Prominent Engineers and Others Assist in Developing Testing Standards

The membership of the committee itself represented men of the highest distinction in engineering and in knowledge of cements. General Q. A. Gillmore was Chief of Engineers of the United States Army. Don J. Whittemore was the Chief Engineer of the Chicago, Milwaukee and St. Paul Railroad. J. Herbert Shedd was in charge of the Providence, R. I., Public Works. Eliot C. Clarke was the Engineer of the Boston Main Drainage Works. Alfred Noble was one of the most distinguished civil engineers in New York. F. O. Norton was the manufacturer of the well-known "Norton Brand" of Rosendale cement. Captain W. W. Maclay was in charge of the concrete work for the New York Dock Department. Thomas C. McCollom was an engineer of construction for the United States Navy and building dry docks at League Island, while L. F. Beekwith was another well-known engineer in New York State. The committee worked hard and did good work, making a foundation upon which specifications were later built.

It was under these methods recommended by the American Society of Civil Engineers that the use of many millions of barrels of both portland

and natural cement in the United States were made, and their elasticity and definiteness produced a state of facts that was bound to lead to new specifications. And it was to meet the "57 varieties" of specifications which engineers of all sorts prepared to suit their own ideas of requirements that the American manufacturer of portland cement struggled from 1886 to 1904. The specifications for various pieces of engineering work, which have been commented upon above, were the subject of a paper on cement and cement testing read by Robert W. Lesley, associate member of the American Society of Civil Engineers, before the Engineers' Club of Philadelphia, in 1898, and were also the subject of an article in "Brown's Directory of Cement Industries," issued in 1901. Mr. Lesley in his paper states that in a period of six or eight years he had gathered various specifications for all kinds of work numbering altogether between two and three hundred, no two of which were alike; while Brown in his book mentions no fewer than sixty different specifications. In the Lesley paper the variations in specifications are classified and many interesting things are shown, among them the great differences between the specifications of engineers in the same department of the government or municipality, the enormous variations in the types of tests to be applied, the variations required in tensile strength and fineness, and the tests for constancy of volume. The author states:

By many specifications, pats of cement in air and water are observed for a period of twenty-eight days for checking and cracking; while by other specifications they are submitted to accelerated tests by heat, by boiling, cooking, stewing, simmering, and other forms of violence for the same purpose.

In addition there were requirements for tests for adhesion, for porosity, for density, for specific gravity, and chemical tests of all kinds and sorts.

Under such conditions it seems a marvel that the American product was able to make its way against the variety of obstacles encountered in these many and differing specifications. However, every evil soon brings about its remedy, and during 1896, at the instigation of Richard L. Humphrey, who for many years had charge of testing for the Bureau of Surveys, City of Philadelphia, and who was himself one of the pioneers in cement testing in this country, a series of editorials appeared in the *Engineering Record*, New York, calling attention to the inadequacy of the recommendations for cement testing of the American Society of Civil Engineers, and urging the appointment of a new committee to revise them.

Following this a resolution was presented by Edward P. North at a meeting of the American Society of Civil Engineers held November 4, 1896, requesting the Board of Direction to report on the advisability of appointing a committee to report on "The Proper Manipulation of the Tests of Cement."

The Board reported at the annual meeting of the society on January 20, 1897, and on July 1st of the same year the Board appointed a committee consisting of George F. Swain, Boston; Alfred Noble, New York; George S. Webster, Philadelphia; W. B. W. Howe, L. C. Sabin, O. M. Carter and H. M. York. The last two members subsequently resigned. On January 16, 1901, the Board of Direction was authorized to increase the membership of this committee to nine, and in accordance therewith appointed S. B. Newberry, Clifford Richardson, Richard L. Humphrey, and F. H. Lewis. Professor Swain was elected Chairman and Mr. Humphrey, Secretary.

Of the men forming this committee, many had most important interests involving the use of cement and their influence in the matter of specifications, as well as the use of cement and concrete, was pronounced. Mr. Swain was one of the leading engineers in Boston, in charge of most important municipal and state work. Mr. Noble, of New York, was later in charge of all the Pennsylvania railroad system of terminals and tunnels into that city. Mr. Webster was the Chief of the Bureau of Surveys of the City of Philadelphia. Mr. Sabin was a distinguished government engineer. Mr. Newberry was then, and throughout his life* remained, one of the great scientific men of the cement industry. Mr. Richardson, who had been in charge of the cement testing laboratory of the United States Government at Washington, has for many years been one of the great chemists and scientists in connection with cement. Mr. Lewis was of the Booth, Garrett & Blair laboratories, and in other chapters of this book his work is fully described, while Mr. Humphrey was then, and is today, one of the leading engineers in cement and concrete, and has given unselfish, continuous, and valuable service to the making of specifications for cement and concrete in the United States.

While this committee was at work, the Board of United States Engineers, appointed by the authority of the Secretary of War, presented a report on methods of testing hydraulic cements, to which was appended standard specifications for both natural and portland cements.

Concurrent with this, the American members of the various committees of the International Association for Testing Materials endeavored to secure the adoption of standard specifications for cement, but this effort came to naught in the way of definite results.

First Step Toward a Standard Specification

This was the state of affairs when at the first meeting of the American Society for Testing Materials in June, 1902, this society, then newly organized and taking the place of the American Section of the International

*Died November 28, 1922.

Association for Testing Materials, the Executive Committee on motion of Robert W. Lesley was authorized to appoint a committee to report on standard specifications for cement. This was the first step toward specifications, and it will be noted further that this action marked the dividing line between the work of the American Society of Civil Engineers, which dealt with methods of testing in its cement committee work, and the Society for Testing Materials, which dealt with the specifications to govern the acceptance of the material itself. The members of the committee named were Robert W. Lesley, Booth, Garrett & Blair, A. W. Dow, Edward M. Hagar, Richard L. Humphrey, Lathbury & Spackman, Andreas Lundteigen, Charles F. McKenna, W. W. Maclay, S. B. Newberry, J. M. Porter, Clifford Richardson and George F. Swain. This committee had power to increase its membership with the approval of the Executive Committee.

The committee assembled at the call of Robert W. Lesley, member of the Executive Committee and temporary Chairman, on October 30, 1902, and organized by the election of George F. Swain, Chairman; George S. Webster, Vice Chairman; and Richard L. Humphrey, Secretary.

The committee was increased by the addition of the following members: T. J. Brady, C. W. Boynton, Spencer Cosby, T. H. Dumary, A. F. Gerstell, William H. Harding, F. H. Lewis, John B. Lober, Charles A. Matcham, Alfred Noble, H. W. Parkhurst, Joseph T. Richards, L. C. Sabin, H. J. Seaman, S. S. Voorhees, W. J. Wilgus, George S. Webster, H. G. Kelly, Vice-President, American Railway Engineering and Maintenance of Way Association; and W. S. Eames, President, American Institute of Architects.

The names composing the committee show that the entire membership of the American Society of Civil Engineers' Committee was appointed on this new committee; that there were representatives of the Association of American Portland Cement Manufacturers, representatives of the great railroads of the country, representatives of the American Railway Engineering and Maintenance of Way Association, and of the American Institute of Architects. It is a very interesting historical fact that this was possibly one of the earliest joint committees appointed by the engineering societies in the United States, a practice which now is universal in dealing with all important engineering subjects.

The American Society of Civil Engineers' committee made a progress report on uniform methods for tests of cement on January 21, 1903, and on February 4, 1903, the new Committee on Standard Specifications for Cement of the American Society for Testing Materials adopted as a basis for its work the report on uniform methods for tests of cement as above stated. A number of examinations of materials were made in order to obtain data for a specification, and finally a tentative specification was presented by Richard L. Humphrey, Secretary, which was considered on

December 3, 1903, approved March 29, 1904, and adopted by the committee by letter ballot on June 11, 1904. It was finally, after approval by the American Society for Testing Materials at its annual meeting, adopted by letter ballot by the Society on November 14, 1904.

Contemporaneous with this work, the Association of American Portland Cement Manufacturers, in December, 1902, appointed a committee on Standard Specifications for Cement, consisting of W. W. Maclay, Chairman; A. F. Gerstell, W. H. Harding, S. B. Newberry, Charles A. Matcham, H. J. Seaman, and Charles F. Wade. The latter committee recommended these specifications for cement, and they were adopted by this Association on June 16, 1904.

On March 19, 1903, the American Railway Engineering and Maintenance of Way Association, at its annual convention, was also at work on specifications. In concluding its report adopting the specifications, the committee on cement specifications stated:

These reports on Uniform Tests of Cement and Standard Specifications for Cement are the result of over six years' labor of a thoroughly representative body of experts, covering every field from the manufacturer to the consumer; they stand for the very best thought on the subject.

The various committees are still in existence and will from time to time recommend such changes as are found by experience to be desirable, thus gradually perfecting the specifications as a whole.

In the meanwhile by the adoption of these specifications a standard of excellence is set which will enable the manufacturer to concentrate his efforts in operating his plant so as to produce uniformly the grade of cement required, and at a minimum cost to the consumer.

This was a great step forward, but as will be shown later, by no means completed work in this field, although it did mean just what the last paragraph of the report said, namely, an opportunity for the American manufacturer, who had shown a spirit of cooperation and willingness to meet every requirement of the engineering profession in the preparation of his product, to manufacture a standard and uniform product—an American portland cement which would meet every requirement of the most critical buyer for every type of engineering work. It was this opportunity of cooperation that brought the great engineers of the country and the early manufacturers of portland cement in close union, and while differences would exist in meetings, the spirit of give and take was always manifested and fair play ruled all the deliberations. It was due to the manifestation of this same spirit of cooperation between manufacturer and consumer that permanent results were achieved. Engineering comment throughout the country was emphatic in its praise of the liberal and conscientious way in which the cement manufacturers had cooperated with the engineering profession.

Leaving the matter of specifications aside, these early years were not lacking in other developments on the scientific side of the industry. There were, as stated in previous chapters, all the developments in machinery and kilns, for example, such as marked Thomas A. Edison's advent into the field of cement manufacture. This well-known inventor, whose long kiln has been described, also devised a system of fine grinding which was



The nineteen-story Medical Arts Building, Dallas, Texas, is now the tallest reinforced concrete building in the world.

used first at the Edison cement works. There were also the numerous contributions by S. B. Newberry, former Professor of Chemistry at Cornell University; those of Professor R. C. Carpenter of the same institution; those of Mr. Richardson and Mr. Sabin on rotary kilns and their use, while William B. Newberry, Professor A. B. Bleining, Professor E. D. Camp-

bell, Richard K. Meade, and others wrote not only on kilns but also on the chemical constitution of portland cement, the use of calcium chloride and gypsum to retard the setting time of cement, and many other subjects of great scientific interest in connection with the industry.

To these were added papers upon cement manufacture appearing in the technical press by Newberry, Lathbury, Spackman, Lesley, Carpenter, Eckel, Meade, Lewis and Lundteigen.

Several trade papers, such as *Cement Age*, *Concrete*, *Concrete Engineering*, *Cement and Engineering News*, and *Rock Products*, sprang into existence, while a number of important books on the subject of portland cement manufacture were published. As a matter of fact everyone interested in cement contributed to the literature current during the period covered by the work of the committees of the American Society of Civil Engineers and the American Society for Testing Materials.

Madison Porter investigated the lack of uniformity in cement testing methods, as stated by Meade in his paper delivered before the American Chemical Society in September, 1906. Maclay, Lundteigen, Lewis and W. Purvis Taylor made a study of the accelerated tests for constancy of volume; Lazell showed the lack of uniformity in standard sieves. Meade proved the sieve test to be inadequate for determining fineness in cements ground by different processes. Taylor investigated the influence of aeration on specific gravity. Spaulding, Jamison, Meade and Taylor published treatises upon the subject of cement testing. Meade says on the subject:

Much improved apparatus for testing cement has also been perfected in this country. Jackson and McKenna have both devised apparatus for determining specific gravity. Gillmore's Needles were for a long time used for testing and setting time of cement, and now that the Vicat apparatus has been recommended, Bramwell has simplified this. The Fairbanks Company manufacture an improved form of testing machine which is much used and possesses many points of advantage over its standard German counterpart, the Michaelis machine. Olsen and Riehle have also brought forward excellent testing machines which are much used in this country. Much has also been done in improving methods of analysis. The New York Section of the Society of Chemical Industry appointed a committee to investigate the subject as did also the Lehigh Valley Section of the American Chemical Society. Both committees reported and advised methods of analysis.

Common Lack of Knowledge on Possibilities of Concrete

The same conditions that governed methods of testing of portland cement, and the same lack of knowledge and experience as marked that branch of the business, were most noticeable in connection with the use of cement in the form of concrete and reinforced concrete. The foreign portland cement brought into this country had been used largely for sidewalks, concrete foundations, brickwork and heavy masonry types of construction. Reinforced concrete was but little known, and while among

engineers there had been considerable study of the work of Coignet, Bordenave and Hennebique in France, Italy and along the Suez Canal, there was little or no general knowledge on the subject. In fact, so marked was this state of affairs during the late nineties that a distinguished contractor and engineer of New York who had been asked to investigate the work of the French concrete engineers with a view of engaging in the reinforced concrete business in this country, reported to his principals that he would not stake his reputation as an engineer upon any such reinforced concrete work as was being done in France, because American labor was too careless and inefficient to observe the nice requirements of successful construction.

Committee Appointed to Study Concrete-Steel Construction

With an illustration of this kind showing the lack of actual information on the tremendous possibilities of reinforced concrete, it is easy to understand how the engineering mind began to focus itself upon the necessity for specifications or methods governing this new art. The American Society of Civil Engineers at its annual convention in Asheville, June, 1903, adopted a resolution for "the appointment of a special committee to take up the question of concrete and steel concrete and that such committee co-operate with the American Society for Testing Materials and the American Railway Engineering and Maintenance of Way Association." Such committee was appointed in May, 1904, consisting of the following members: J. E. Greiner, Consulting Engineer, Baltimore and Ohio Railroad, Baltimore; W. K. Hatt, Professor of Civil Engineering, Purdue University, Lafayette, Indiana; Olaf Hoff, Vice President, Butler Brothers, Hoff & Company, New York City; Richard L. Humphrey, Consulting Engineer and Engineer in Charge of St. Louis Structural Materials Testing Laboratories of United States Geological Survey, Philadelphia; Robert W. Lesley, President, American Cement Company, Philadelphia; J. W. Schaub, Consulting Engineer, Chicago; C. C. Schneider, Consulting Engineer, Philadelphia; Emile Swensson, Consulting Engineer, Pittsburgh, Pennsylvania; A. N. Talbot, Professor of Municipal and Sanitary Engineering, in Charge of Theoretical and Applied Mechanics, University of Illinois, Urbana; J. R. Worcester, Consulting Engineer, Boston.

The first meeting was held at Atlantic City in June, 1904, and the name was changed to Special Committee on Concrete and Reinforced Concrete. C. C. Schneider was appointed Chairman, and J. W. Schaub, Secretary. Subsequently, Mr. Schaub resigned and Richard L. Humphrey was appointed Secretary on October 11, 1905.

Formation of Joint Committee on Concrete and Reinforced Concrete

Concurrent with this work of the American Society of Civil Engineers' committee, the American Society for Testing Materials in December, 1903, appointed a Committee on Reinforced Concrete while the American Railway Engineering and Maintenance of Way Association, in March, 1904, authorized its Committee on Masonry to cooperate with the Special Committee on Concrete and Reinforced Concrete of the American Society of Civil Engineers referred to above. At a meeting of the several special committees representing the above mentioned societies held at Atlantic City, June 17, 1904, arrangements were completed for collaborating the work of these several committees through the formation of a Joint Committee on Concrete and Reinforced Concrete. C. C. Schneider was elected temporary Chairman and Professor A. N. Talbot temporary Secretary, and among the first acts of the new Joint Committee was the extending of an invitation to the Association of American Portland Cement Manufacturers to join in its deliberations through a committee appointed for the purpose.

The Joint Committee thus formed consisted of ten appointees from the American Society of Civil Engineers, fifteen from the American Society for Testing Materials, five from the American Railway Engineering Association, and four from the Association of American Portland Cement Manufacturers. To follow the history of this committee from its organization in 1904 to the present date would involve the writing of a book on concrete and reinforced concrete. The progress report presented to the various constituent societies in the year 1912-1913 embodied a bibliography of the art and a series of chapters dealing with the materials, the uses, the adaptability of concrete and reinforced concrete, forms, design, and the various other elements entering into the successful use of these new materials of construction. It was no easy task to obtain the practically unanimous report on a subject of such wide scope and much credit is due to the secretary, Richard L. Humphrey, who certainly kept the committee in action and contributed much to the important results obtained. At one time it became necessary almost to keep the committee together like a "hung jury," hardly permitting them to separate for sleep and practically insisting that they should take all their meals together until their deliberations produced fruit.

In both of the preceding cases the appointment of committees and the ensuing results grew out of evils and lack of knowledge among those having to do with the subject matter under discussion. The adoption of a uniform cement specification had been a great step forward and so was the Progress Report of the Committee on Concrete and Reinforced Concrete. In both cases new light was obtained and evils were cured, and it is a remarkable

fact in considering the work mentioned that the joint committees or committees formed of representatives of all interests were engaged in the work and practically marked the advent of a new form of engineering cooperation. It was still further remarkable that while the subject under consideration was that of cement in which large interests were involved on its manufacturing side, nevertheless, in the case of both of these committees there was a large preponderance of representatives of consumers (engineers, testing laboratories, etc.) as distinguished from producers (manufacturers, contractors, etc.) thus showing the fair spirit in which the cement manufacturer had dealt with the subject of tests from the earliest days of discussion. This marked a material difference in respect to these committees as compared with other and similar bodies of the American Society for Testing Materials so far as the representative proportionate constituents of producers and consumers were concerned.

Through these two great engineering bodies, working along the lines stated, many evils were remedied and much work of great value was done; but there remained still another side of the subject and one that involved great peril to the growing industry of cement and its many uses. While the recommendations for the tests of cement and the recommendations for the use of concrete and reinforced concrete showed the way in broad and greater lines, there had developed a large field for the use of cement in sidewalk work and in the making of brick and block. It was necessary that some method of supervision or at least of correlated thought should be found to obviate any possible evils growing out of bad work in these two fields.

National Association of Cement Users Organized

The formation in 1905 of the National Association of Cement Users, whose first convention was held at Indianapolis that year, was a step in this direction. The purpose of this association, which was incorporated in 1906, was to bring into one organization that great body of smaller contractors and cement users who were working in the fields mentioned. Especially was it the purpose to gather together the proper information and data to govern the manufacture of cement block and brick, which were coming into use in a large way and causing considerable trouble and discredit in some cases to the makers and sometimes to cement itself.

At the first meeting of this association, Richard L. Humphrey was elected president and continued in that office from 1905 until 1915 as President of the National Association of Cement Users, and its successor, the American Concrete Institute, a strong and flourishing organization. Interesting contrasts between the early days of this organization, whose members at first were chiefly the non-technical but very practical type of working contractors and block makers, to the more deliberative and

scientific organization that now exists, may be cited. The one great feature of the early conventions was the "Question Box," in which every one who did not know, was invited to put his question to be answered by someone who did know. This produced excellent results and was one of the elements that bound the early members thoroughly together. The development, however, of the society from its early purposes, which were rather along the lines of selection of different types of block making machinery and of the methods of making block and sidewalks, to the high engineering lines it now covers, was due to the fact that from its earliest day the society had at its head an engineer preeminent in the field and whose influence was always toward the elevation of the standards and ideals of the organization. When Mr. Humphrey resigned he was succeeded by Leonard C. Wason, another leading exponent of concrete construction. Mr. Wason was succeeded by Professor W. K. Hatt, and he in turn by H. C. Turner, all eminent authorities in the field.

It was a fitting tribute to the development of the art of testing and of the making of specifications for materials in the United States when the International Association for Testing Materials, representing practically all the leading nations of the world decided to hold its Fifth International Congress in New York in 1912, where the subjects should have the widest discussion by authorities of world-wide standing. Illustrating the growth of cement and of concrete and reinforced concrete in the engineering mind, it is sufficient to state that one section of this great congress was devoted to these subjects alone, and papers were read and discussion had upon their many-sided elements by men of the greatest distinction from France, Germany, England, Denmark, Russia, Italy, and some of the South American countries. The deliberations were in French, in German, and in English, and the section over which Robert W. Lesley, the Vice President of the American Society for Testing Materials presided, had among its other presiding officials, Dr. Schule, of Switzerland; Dr. Reitler, of Vienna, and Dr. Foss, of Copenhagen.

Single Standard Specification Adopted by All Engineering Societies and United States Government

After the presentation of the first report of Committee C-1 on Cement Specifications in 1904, wherein the first standard specifications were adopted, it was found that a number of changes requiring revisions of the specifications were necessary. This led to the first revision adopted in 1908 and a second revision in 1909; and for a time the specification was in existence and successfully used in practically all branches of the engineering profession except under government contracts. As a result of efforts to correlate the government specifications with those of the Com-

mittee C-1 on Cement Specifications, many conferences were had, covering a period of several years, between representatives of the government and of the committee above referred to. As a result of this, a third revision was adopted in 1916 to become effective January 1, 1917, which represented practically an agreement between the United States Government engineers and representatives of the committee. Much heated discussion was had at various meetings before the adoption of this specification. Under nine sub-committees of the general Committee C-1, dealing with the elements of the specification, an agreement was arrived at on all points and the result of the study of the committee, which was published by it under the auspices of the American Society for Testing Materials, is a classic so far as records of various methods of testing are concerned. The final agreement under the fourth revision was adopted in 1920 and became effective January 1, 1921, and represents an agreement between all authorities in the United States having to do with the making of a single uniform cement specification. This specification, approved January 15, 1921, is the first standard United States Specification to be adopted by the new Engineering Standards Committee of all the engineering societies. The Committee C-1, whose specifications are above referred to, consisted of thirty-seven non-producers (consumers, engineers, testing laboratories, etc.) and twenty-five producers (manufacturers of portland cement).

On March 31, 1922, this specification became the first American Standard Specification marking common accord among the various engineering societies who had long contributed to the work. The United States Government Specification also included exactly the same requirements. These specifications are given in Appendix D of this volume.

As mentioned before, the Committee on Concrete and Reinforced Concrete originally appointed by the American Society of Civil Engineers, subsequently forming the Joint Committee, whose report on dealing practically with methods of concrete and reinforced concrete construction had been approved by the various constituent organizations, finished its report. The subject, however, like the subject of cement specifications and methods of testing cement, was not finally concluded, as it remained still a duty for someone to actually make specifications for reinforced concrete. Accordingly, on June 27, 1917, Committee C-2 of the American Society for Testing Materials considered the recommending of specifications for concrete and reinforced concrete and adopted resolutions to that end. In August, 1917, its recommendations in the matter were presented to the Executive Committee of the American Society for Testing Materials. This Committee took favorable action upon the report of Committee C-2 recommending that the American Society of Civil Engineers, the American Railway Engineering Association, the American Concrete Institute and the Portland Cement Association be invited to "form with our Society a Joint Committee

for the purpose of preparing specifications for reinforced concrete," these four organizations, with the American Society for Testing Materials, having cooperated in the work of the former Joint Committee on Concrete and Reinforced Concrete. The Executive Committee extended invitations to these four organizations, and by November 22, 1919, acceptances had been received from all of them. The five cooperating bodies agreed to appoint



An interior view of the Sacred Heart Church, Washington, D. C. The concrete work was executed by John J. Early, architectural sculptor.

five representatives each to the Joint Committee. After receipt of these replies naming the representatives, a call was issued by the Executive Committee of the Society for Testing Materials to the 25 representatives thus appointed to attend an organization meeting on February 11, 1920. At this meeting Richard L. Humphrey was elected Chairman, J. J. Yates, Vice Chairman and Duff A. Abrams, Secretary. Committees were appointed on the subject of: materials other than reinforcing, metal reinforcement, proportioning and mixing, forms and placing, design, details of

construction and fireproofing, waterproofing and protective treatment, surface finish, form of specification.

The first report of this committee, entitled, "Progress Report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete," was published in June, 1921. Since that time the report has been thoroughly discussed before each of the constituent societies and by individuals through the medium of the technical press and otherwise. In the light of this discussion and of field tests to demonstrate the practicability of some of the recommendations contained in the progress report, the committee has made quite a number of amendments which, included in a new report, are published in the October (1924) proceedings of the American Society of Civil Engineers.

Much that represents a distinct advance with regard to refinements of design is included in the report. Recognition of the dependability of the strength of concrete when scientifically proportioned, carefully placed, and properly cured, shows that marked advance has been made in the scientific study of this material and of its practical uses.

The report is not submitted as final and future amendments will probably be made, but in the general application of the specifications, the committee considers its forthcoming report as practically completing its endeavors.

At the present time (October, 1924), the membership of the Joint Committee is as follows:

AMERICAN SOCIETY OF CIVIL ENGINEERS

W. A. Slater, Chairman,

Engineer-Physicist, U. S. Bureau of Standards, Washington, D. C.

Milton H. Freeman,

Division Engineer, N. Y. & N. J. Bridge & Tunnel Comm., New York City.

A. E. Lindau,

President, American Wire Fence Company, Chicago; formerly General Manager of Sales, Corrugated Bar Company, Buffalo, N. Y.

Franklin R. McMillan,

Consulting Engineer, 628 Metropolitan Bank Building, Minneapolis, Minn.

Appointed to fill vacancy.

Sanford E. Thompson,

Consulting Engineer, Boston, Mass.

W. K. Hatt,

Professor of Civil Engineering, Purdue University, Lafayette, Ind.

Resigned Sept. 14, 1921. Succeeded by Milton H. Freeman.

Rudolph P. Miller,

Consulting Engineer, New York City.

Resigned March 28, 1921. Succeeded as Chairman by W. A. Slater.

AMERICAN SOCIETY FOR TESTING MATERIALS

Richard L. Humphrey, Chairman,

Consulting Engineer, Philadelphia, Pa.

Albert T. Goldbeck,

Engineer of Tests, U. S. Bureau of Public Roads, Washington, D. C.

Edward E. Hughes,

Vice-President, Franklin Steel Works, Franklin, Pa.

Henry H. Quimby,

Chief Engineer, Department of City Transit, Philadelphia, Pa.

Leon S. Moisseiff,

Engineer of Design, Delaware River Bridge, Brooklyn, N. Y.

AMERICAN RAILWAY ENGINEERING ASSOCIATION*

J. J. Yates, Chairman,

Bridge Engineer, Central Railroad of New Jersey, Jersey City, N. J.

T. L. D. Hadwen,

Engineer of Masonry Construction, Chicago, Milwaukee and St. Paul Ry., Chicago.

Frederick E. Schall,

Bridge Engineer, Lehigh Valley Railroad, Bethlehem, Pa.

C. C. Westfall,

Engineer of Bridges, Illinois Central Railroad Company, Chicago.

George E. Boyd,

Division Engineer, Delaware, Lackawanna and Western R. R., Buffalo, N. Y.

Resigned November 7, 1921. Succeeded by T. L. D. Hadwen.

H. T. Welty,

Engineer of Structures, New York Central Railroad, New York City.

Resigned December 27, 1922.

AMERICAN CONCRETE INSTITUTE*

S. C. Hollister, Chairman,

Consulting Engineer, Philadelphia, Pa.

Robert W. Lesley,

Past President, Portland Cement Association, Pennsylvania Building, Philadelphia, Pa.

Egbert J. Moore,

Vice President, Turner Construction Company, New York City.

Angus B. McMillan,

Chief Engineer, Aberthaw Construction Company, Boston, Mass.

Arthur R. Lord,

President, Lord Engineering Company, Chicago.

Resigned April 17, 1923.

Leonard C. Wason,

President, Aberthaw Construction Company, Boston, Mass.

Resigned October 19, 1920. Succeeded by Angus B. McMillan.

PORTLAND CEMENT ASSOCIATION

Frederick W. Kelley, Chairman,

President, Portland Cement Association, 126 State Street, Albany, N. Y.

Duff A. Abrams,

Professor in Charge, Structural Materials Research Laboratory, Lewis Institute, Chicago.

Ernest Ashton,

Chemical Engineer, Lehigh Portland Cement Co., Allentown, Pa.

Edward D. Boyer,

Cement Expert, Atlas Portland Cement Company, New York City.

A. C. Irwin,

Engineer, Structural Bureau, Portland Cement Association, Chicago.

*At the time of the completion of this report a vacancy existed in the representation of both the American Railway Engineering Association and the American Concrete Institute.

Many Cooperate in Study of Cement, Concrete and Aggregates

To give some idea of the importance of the field covered by cement and concrete in the work of the American Society for Testing Materials alone, it may be stated that the number of committees having to do with the two subjects is no fewer than twenty-eight; and again it may be stated that in each of the great main committees, namely, the committees on cement, concrete and reinforced concrete and on aggregates, the representation of consumers and producers is respectively 37 nonproducers, 25 producers; 16 nonproducers, 5 producers; and 23 nonproducers, 11 producers, again emphasizing the fair play that governed the constitution of the committees and the work in general.

In looking over the names of those who had to do with all the work above described, certain individuals stand out, among them C. C. Schneider and Emil Swensson, who were on the original Committee on Concrete and Reinforced Concrete and represented important steel and bridge constructing interests, but who took active part in the early work of the committee. There were also Professor W. K. Hatt, of Purdue University; John B. Lober, Vulcanite Portland Cement Company; Robert W. Lesley, American Cement Company; S. B. Newberry, Sandusky Cement Company; Ernest Ashton, Lehigh Portland Cement Company; George S. Webster, Philadelphia; Rudolph J. Wig, United States Bureau of Standards; R. B. Young, Pennsylvania Railroad; H. H. Quimby, Bureau of Surveys, Philadelphia; Sanford E. Thompson, Boston; S. T. Wagner, Philadelphia; A. N. Talbot, University of Illinois. All these men contributed of their time and ability to the furtherance of the work and may be classed among those who were associated with the committees in their early days and many of whom are with them still.

With the growth of new thought and the advent of new men, valuable additions have been made to the committee by the appointment of A. C. Tagge, Canada Cement Company; F. W. Kelley, Helderberg Cement Company; W. M. Kinney, Portland Cement Association; P. H. Bates, United States Bureau of Standards; R. S. Greenman, New York Canal Board; A. T. Goldbeck, United States Bureau of Public Roads; S. C. Hollister; E. L. Conwell, Conwell Testing Laboratories; C. N. Chapman and N. C. Johnson, all of them representing modern thought and ideas.

It is difficult to enumerate in this day all the writers of importance in the field of cement and reinforced concrete within the past fifteen years. While the earlier writers were few and far between, the field has so broadened and so many men of distinction and great minds and intelligence have contributed in scientific papers and in magazine articles, books, etc., to the subject, that it would take up considerable space to name them. So, too, it would be invidious to name some to the exclusion of others of that

body of disinterested scientists who at the various meetings of the Portland Cement Association contributed papers dealing with all branches of concrete and of the manufacture of cement. These papers form in themselves a compendium of knowledge and emphasize, as do all the proceedings, the broad and thorough development of the scientific side of the industry.

From an examination of the preceding facts it will be noted with what full spirit of cooperation and with what unselfish, altruistic interest the cement industry gave itself to the solution of the problems involving the specifications for its material and the use of concrete and reinforced concrete. The broad definition of "service" may well apply to the work done. In time, in money, in suggestion, and in action, the cement manufacturers were found at all times in the forefront of the various committees and organizations dealing with these important subjects pertaining to their product. It is a tribute to a trade organization such as the Portland Cement Association that in all the joint committees dealing with cement, concrete, and reinforced concrete that body should have a definite representation and be invited to join in the action to be taken.

CHAPTER XII

THE DAY OF THE PROMOTER

Michigan and Kansas Give the Promoter His Cue

The great development of the cement industry by the construction of new mills in the marl fields of Michigan and in the gas territory of Kansas was a signal for the "promoter" to rush in and organize new companies. The growth of the Michigan and Kansas fields, together with the increase of cement business generally throughout the country, resulted in many exaggerated statements concerning the profits of the industry. The attention of unscrupulous promoters was attracted to this promising field for their talent, beginning as far back as 1897 and continuing all through the first decade of the present century. They were ready to take advantage of the situation following the wonderful growth of the new industry in the short period since it had been founded, and began organizing companies in which the get-rich-quick appeal was successfully used.

The stock salesman, the banker, the printing press, the photographer and the lithographer were all impressed into the service, and while the number of promoters was small compared with the number in some other industries, notably mining, the situation became sufficiently acute to attract attention. In 1908 Edwin C. Eckel, in his book entitled "The Portland Cement Industry from a Financial Standpoint," published an interesting account of this phase of the industry, the following paragraph from the preface of his book describing the situation concisely:

Eckel Warns Against the Promoter

There is at present every indication that the first broad improvement in the general business situation will be the signal for the attempted flotation of an unprecedentedly large mass of cement securities. Some of the enterprises against which these securities are issued will ultimately prove successful and profitable; some, though exploited honestly, will prove to have been mistakenly planned; a third and not inconsiderable group of projects will be exploited for the sole purpose of defrauding the investors.

Typical Example of His Methods

After calling attention to the great and growing importance of the portland cement industry, and how properly financed, located, constructed and managed plants had made satisfactory returns to the stockholders, Eckel exposed the fraudulent methods in operation. A promoter, he said,

passing through a prairie state might notice an abandoned lime kiln, and in his mind would be created immediately the Great Plains Cement Corporation. He might secure an option at \$10 per acre on 200 acres of land worthless for farming purposes and obtain from some state geologist or college professor a perfectly honest statement to the effect that the land contained some fifty million tons of cement raw materials. Inasmuch as the United States Geological Survey reports showed that the average value of the limestone quarried the preceding year was \$1.20 per ton, the promoter was in a position to convince prospective investors that even at ten cents a ton the limestone deposit upon which he had obtained an option, or had purchased outright, was worth at least \$5,000,000, to say nothing of the value of the shale for brick-making purposes. Thereupon the stockholders were congratulated upon being the owners of this magnificent reserve of raw material at a cost of less than one-twentieth of its real value as certified to by experts.

Panama Canal Project Used to Lure Investors

Glowing prospectuses were sent out, most of them to the effect that the portland cement industry had an immense future and that failures among manufacturers were unknown. The Panama Canal project was stressed to the breaking point. A favorite statement was that the construction of the canal would consume daily more than a third of the entire output of portland cement, thus serving to increase the price. Estimates of profits were easy to figure, even where costs of production were placed at the maximum "to be on the safe side." The following is a sample statement given by Eckel:

3,000 barrels per day, 1,095,000 barrels per year, at \$1.50	\$1,642,500
Cost to manufacture, 1,095,000 barrels, at 60 cents.	657,000

Profit of company per year	\$ 985,500
The entire plant will cost, ready for operation, not over	\$750,000.

In reading some of the prospectuses—among them those sent out with honest intent—the only conclusion to be formed was that the Almighty, in creating the world, had set aside certain tracts for the advantage of these specific enterprises. In some cases waterways and railways extended from the site to the most profitable markets of the country. Water needed for industrial purposes flowed through the premises. Not only were all necessary materials on the ground, but so arranged as to be conveniently accessible, even including the coal required for burning. The store of these was inexhaustible and their quality superb and uniform, the cement material testing higher than any previously discovered. The site of the mill had been prearranged so that materials would slide into it by gravity. Even the climate was admirable, and for some strange reason all the

workingmen who had chanced to settle in the community were of loyal, native stock not likely to be in sympathy with labor agitators. The foregoing may appear as an exaggerated statement, but precisely such claims may be found in some of the old prospectuses.

Generally the Promoter Knew Nothing About the Business

The period was marked by the general distribution of prospectuses of all kinds describing all sorts of property available for cement manufacturing, located in all parts of the United States, and embracing materials of all kinds and character. Many of them were issued by people entirely unfamiliar with the business, while others were skillfully and carefully prepared to attract the unwary investor. Some of these represented the highest standards in the art of engraving, printing, and binding, and the text or literary effort was exceedingly clever and plausible. Through these circulars, especially in the farming country of the Middle West, and notably in the Michigan territory, large numbers of small investors were drawn into the business, many of them receiving little or no returns for their investments.

As far back as 1897 an Ohio prospectus was filled with striking data. After stating that "the ancients used cement with success on a grand scale that awakens astonishment in the mind of the modern engineer," it refers to the probable large increase in the American product from the 2,340,000 barrels then made. The property described by the prospectus was said to contain "large deposits of carbonate of lime, clay, and fuel of the required physical and chemical characteristics in economical proximity, which are so rare as to give to the owners of these quarries a practical monopoly of the manufacture of portland cement on a large scale west of the Alleghenies. This practical monopoly will be worth millions for the purpose of a large factory." It continues: "Where small deposits of the requisite materials exist, a number of small factories have sprung up, but the limited supply of the material prevents the expansion of these plants as well as the use of the best machinery which is costly. Their combined output will not equal 500,000 barrels per annum and can never be an important factor in the American portland cement industry." The prospectus promised profits of from 40 to 80 per cent per annum.

It is safe to state that this works was never built and the small mills then existing in the West still live.

The Usual Way of Figuring Profits

A modest type of prospectus of the early days was that of the cement company which intended to build a plant on a tract near the town of

Phillipsburg, N. J. Only \$150,000 was required to start the business, apportioned as follows:

Land—75 acres at \$750, will cost	\$56,250
Buildings and machinery complete as per accompanying estimates ..	50,000
Working capital needed during first year's run	20,000
Balance of stock—to be issued as needed	23,750

These figures as contrasted with the average prospectus are so modest that the claim of \$1 per barrel as the price of manufacturing and \$1.60 as the selling price shocked no one and illustrate in what small beginnings great works had their origin. A final supplementary statement says:

The manager of the company is ready to agree to deliver cement on board cars at \$1.10, and that "Mr. Bonneville will take all they can turn out at \$1.50 per barrel."



The concrete tennis courts of the Los Angeles Tennis Club on which many championship matches have been played.

A Nebraska prospectus at the town of Superior, with a population in 1900 of 2,140 souls, is dated New York, March 6, 1902. It proposes a works of 1,000 barrels capacity for \$231,000 and claims the ability to deliver cement in the large markets of Colorado, Wyoming, Nebraska, Kansas, Oklahoma, Iowa, Missouri, Minnesota and Montana at an average of 40 cents lower than any other plants in that vicinity.

The original prospectus of a Colorado company promised control of the Rocky Mountain market, and states that "of the \$2 per barrel that the dealer pays here \$1.25 should be profit to the producer." The material is alleged to be "a most natural quality of cretaceous rock of the exact proportions and the chemical combinations proper and desirable both for quality of cement and facility of manufacture." The mill is all operated by gravity and also, "fine grinding of the raw material is not essential as nature has already accomplished a proper mixture."

A very moderate capitalization was contemplated by land owners in Texas, where one offering a property for sale stated that, "a friend of mine here owns a stupendous deposit of limestone and shale adjacent to the corporate limits of this city."

A portland cement company proposed to build a plant in Ohio. Needless to say, the land contained an ample supply of raw materials of the best quality, exceptional transportation facilities, abundance of fuel and water and a plant site. The tests made, of course, equalled the best American brands then in existence and all the materials were lower than could be obtained anywhere else.

The first works to be financed upon the basis of the limestones in the Western Pennsylvania district was to cover a 1,000,000 barrel output to be sold at \$2 per barrel. The annual net profit, after paying 7 per cent on \$1,250,000 of preferred stock, was figured at \$1,312,500, which was "going some," even in those days.

Another Ohio cement company, with a capital of \$600,000 in stock and \$400,000 in bonds proposed a factory of only 1,200 barrels per day, which would make, on the basis of \$1.65 per barrel, a mere bagatelle of \$299,400. Honesty prevented them from running it up to the even \$300,000.

In New Jersey a plant was projected which required \$650,000 capital and which modestly proposed to make cement for 55 cents a barrel. The cost of machinery was modestly stated as \$89,000, and as an appeal to prospective stockholders, it was stated that dividends of other cement companies had run as high as 37 per cent per annum.

A works projected in Pennsylvania had among its most attractive features the fact that it was the only cement works on the great Pennsylvania Railroad system, and it was stated that the millsite was so near the quarry that the "closeness of the underlying rock to the surface insures good foundations for the massive machinery at a comparatively low cost." This concern proposed to have its own railroad to connect with the Pennsylvania system, and to yield to the common stockholders nearly 10 per cent on their investment, after paying 7 per cent on the preferred.

A Kentucky prospectus was predicated upon the fact that limestone, clay and shale were all found on a single property which, together with the "topographical situation makes it possible to collect the materials for

making cement at the lowest possible cost." A further advantage was that coal, "which represents about one-half of the cost of the manufacturing of portland cement at mills where the fuel is burdened with expensive transportation, is on this property so that the cost of manufacturing will be at figures unapproachable by mills not having the same fortunate combination of fuel and materials."

One of the most remarkable of all these prospectuses was, however, that of a Michigan company which had a capitalization of \$5,000,000 and owned 6,200 acres of land in Michigan. Regarding this it was stated that this was "the greatest area of raw material owned by any portland cement company in America or Europe and will supply a plant of 12,000 barrels per day capacity for nearly 100 years, while the buildings of the completed plant will cover about 17 acres." The original estimate was made upon a cost of 59.90 cents per barrel with a selling price of \$1.40, while in a later "summary" of the prospectus it was figured that the cement could be manufactured for 50 cents per barrel. The "Table of Estimated Earnings," covering a period of 10 years, started with earnings of \$1,168,000, on a capacity of 4,000 barrels a day, and ended with a capacity of 12,000 barrels a day, by which time a surplus of \$4,658,634.60 would have been accumulated, of which, if the cement could be made at 50 cents per barrel as stated in the "summary" \$3,577,000 would be added to the profits for the 10-year period. This was an actual concern which started to build a plant, spent a great amount of money and constructed a town of its own in the State of Michigan. Later on the property was sold under mortgage, and added one more to the list of unsuccessful promotions.

Effect of Wildcat Promotion on Industry

The effect of some of these promotions upon the industry was anything but constructive, as the values given and profits sought brought into being in many cases plants which at the time of their construction had no logical right to exist.

The subject of this boom is largely covered in the interesting book by Eckel already referred to and in his article published in the Engineering Magazine, March, 1911, under the title of, "The Iron and Cement Industry," as well as in two pamphlets published at the time, one in 1916 entitled "Has the Cement Bubble Burst?" by E. W. Stanfield, Kansas City, and the last, a most important and interesting one, entitled, "The Pathetic Case of the Gointohel Cement Company." These all throw a most interesting light on the subject and bring into the field of the pioneer and the developer of the industry, the new character of the promoter, whose efforts spread all over the land. Some of his work still lives, while much of it has gone the way of all flesh, even where projected with honest intent and the conviction that he had a sound proposition.

The result of a great many of these promotions, together with the extremely low prices prevailing, in the industry during the years 1908-9-10 and 1911, was to put into the hands of creditors 32 mills, which were either reorganized at great loss to their stockholders, or were at that time—when a tariff bill was under discussion—idle.

While this promotion of individual works was going on, and many misadventures came to investors, several consolidations of various cement plants were proposed by financiers and promoters. But none of them was effected and the industry remained “the most individualistic of the larger branches of manufacture.”

CHAPTER XIII

THE CONSTRUCTORS

An Early Period of Rapid Transition

The period from 1900 to 1910, according to figures of the United States Geological Survey, was one of remarkable and rapid growth. The output increased from 8,402,020 barrels, valued at \$9,280,525, in 1900, to 76,549,951 barrels, valued at \$68,205,800, in 1910. The salient feature of this decade was the enormous amount of new capital that had come into the business and the great improvement in mechanical and commercial methods. The pioneers of the early days were left far behind, one might say, their conception of works being a plant with an output of 200 to 300 barrels a day. Even those who were concerned with the growth in the secondary formation began to take back seats. This third period of readjustment in the portland cement industry represented the incoming of financial institutions, banking interests and captains of industry, and also the beginning of what now marks the great groupings in the cement trade. First and foremost was the search for greater economies in production; second, the increase in size and extent of quarries and mechanical devices; and third, the search for new and cheaper fuel and for fuel conservation, as well as more varied material for production.

Discovery of Natural Gas as Kiln Fuel

The first part of this chapter may well be devoted to the remarkable discovery of the adaptability of natural gas to rotary kilns, and the fact that in Kansas a great natural gas region had developed where this fuel could be had at practically nominal cost and in what were then claimed to be inexhaustible quantities. This led to the rapid development of plants in Kansas. The first of these, the Iola Portland Cement Company, was financed in New York and St. Louis and was a success almost from the early days of its operation. George E. Nicholson was the President and the Leigh Hunt Engineering Company built the works. This plant was followed by that of the Kansas Portland Cement Company nearby, and in the same year, 1905, a third plant was projected at Independence. The raw materials, limestone and clay or shales, were satisfactory, but the real advantage lay in the cheap fuel found in natural gas. Owing to the success of the first mills, a wild era of stock promotion started in and

millions of dollars were poured into this field by investors from all parts of the country, so that in 1910 Kansas ranked fourth among the portland cement producing states, being exceeded only by Pennsylvania, Indiana and California.

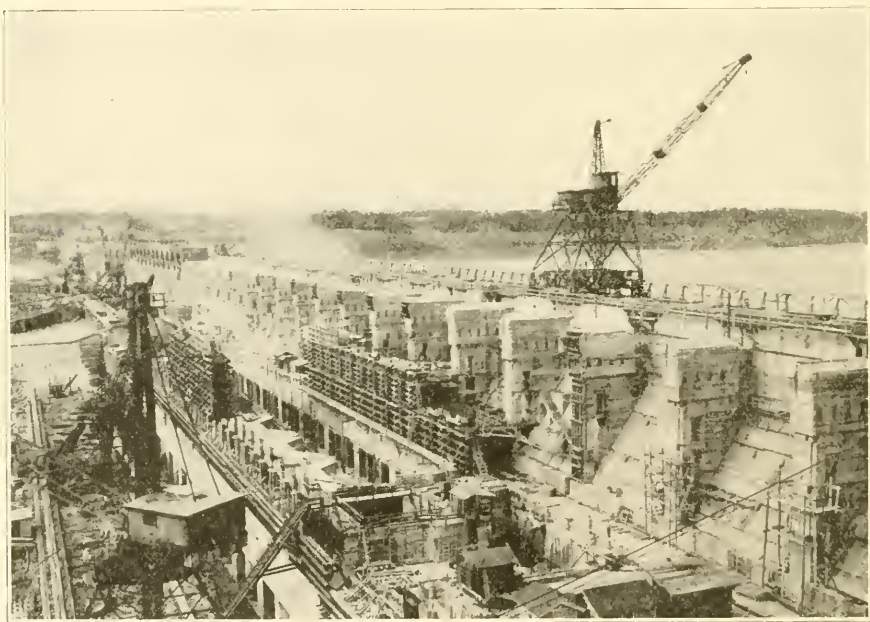
The state then had ten plants, all except one using a mixture of carboniferous limestone and shale; the exception using chalky limestone and shale. All of the plants in the natural gas area originally used the natural fuel, but in 1911 three used oil exclusively and others oil with gas, while the rest were preparing to use oil or coal in case of scarcity of gas. Thirteen plants were in operation in 1911 and ten were operated in 1912. The state produced nearly 5,000,000 barrels of portland cement in 1911 and about 3,250,000 in 1912. By 1920 the number of plants had fallen to seven, with a production of about 3,000,000 barrels. After the maximum had been reached in the number of mills and production, the latter finally exceeded the market requirements, which the manufacturers charge was largely, if not wholly, due to discriminatory freight rates adjustment and the building of competing mills east of the Missouri River, which enjoyed a lower scale of freight rates, and which, it was alleged, more than offset the supposed advantage of cheap fuel. As a consequence but seven mills were operating in 1920, and of these, three had gone through bankruptcy one or more times, while the others were compelled to reorganize and work out plans to raise money to re-establish plants and provide for heavy financial losses. It was estimated in 1920 that interest at 6 per cent for an average of twelve years on the money lost in cement securities and investments in Kansas would amount to considerably over \$8,000,000. A great part of the loss in this district was caused by the exhaustion of the natural gas. At the end of the period, when the gas was still available, pipe lines of forty and fifty miles were built to bring in additional supplies from far-off territory, and finally these pipe lines were sold and the mills turned generally to coal as a fuel.

In this same period the Michigan* region, which had also developed in a time of high prices, was forced, owing to the character of its raw materials and the handling of them by the wet process with higher priced fuel, to seek economies. As a result, a number of mills were successful in securing limestone within reasonable reach of their plants and turned from the wet to the dry process and abandoned the marl beds which, in many cases, were exhausted. In this region, as already indicated, and in the country at large, capital began to come in in large sums and the days of wild promotion described in a previous chapter gave way to consolidations or groups of plants under a single management.

*A more extended account of the development of the industry in Michigan appears in the chapter on "Early Manufacturers."

Pacific Coast States Enter Portland Cement Field

During this period, namely, the decade from 1900 to 1910, California began to produce portland cement. As a portland cement manufacturing center the Pacific coast, in the early days, was as detached almost as a foreign country in so far as its relation to Eastern progress in the industry was concerned. Large quantities of cement had been imported at San Francisco for years, beginning in 1864 with about 13,000 barrels, which reached approximately 150,000 barrels in 1884, importations in New York that year amounting to about 350,000 barrels, showing that the Pacific coast was a large user of cement at that period. Seattle, Portland and San Francisco were the natural markets for the use and distribution of this foreign cement.



Building the Wilson Dam at Muscle Shoals, Alabama. This is the largest concrete masonry dam in the world.

Conditions governing the importations of portland cement on the eastern coast, so far as tramp vessels and low freight rates were concerned, were even more marked on the western slope of the United States. One of the old wooden sailing type of vessels would start from London, Antwerp or Rotterdam with large cargoes of cement practically going as ballast and get high-paying return cargoes of grain from the shipping centers on the Pacific coast. It took them six months to make the trip from Europe around the Horn to California or Oregon.

The first plant to make a true portland cement on the Pacific coast was that established in Oregon in 1884 under the management of Middleton, which has been described in detail elsewhere. Among those who became interested in the future of this region at an early period was Uriah Cummings, who looked over the field in 1894, contemplating establishing a plant at Los Angeles. He found that railroad tariffs were so excessive that little profit was promised and so abandoned his purpose. According to Charles A. Newhall, in *Concrete-Cement Age*, the first plant to operate in California was started in 1898 by the California Portland Cement Company at Colton, about fifty miles east of Los Angeles. This plant had an initial capacity of 500 barrels per day and in its early years suffered from nearly all the diseases to which cement manufacturing was subject. Later on it was remodeled, and the capacity increased to an output of about 2,500 barrels per day. T. J. Fleming was the man who worked through all the trouble and reorganized and rebuilt the plant. Up to the time of his death (February 27, 1924) he was one of the most successful manufacturers in southern California.

In 1901 the Pacific Portland Cement Company was incorporated, and began operating its plant in northern California in 1902. It had for its president General Stone, who had been a distinguished soldier in the Civil War. He had as associates Nathan L. Bell and Morris Kind, the latter now the President of the Hercules Portland Cement Company, Philadelphia. General Stone was always willing to do his mite for the industry, and his work in connection with Messrs. Henshaw, Lober, Lesley, and others in the matter of the Government construction of the Roosevelt Dam was most valuable, believing with others, as he did, that the building of cement works was no function of the Government.

In the same vicinity the Standard Portland Cement works was established in 1902—at Napa Junction—and began operations in 1903. William J. Dingee, a California capitalist and Dr. Irving A. Bachman, who had come to the Pacific field after some chemical knowledge of the Nazareth district in Pennsylvania, were in charge. These men were also the pioneers and managers in the construction of the Santa Cruz Portland Cement works, which went into operation in 1901. Believing in the great future of the portland cement industry, which in the period mentioned was successful in many parts of the United States, these men started to build a plant in Washington, but did not carry their operation to a conclusion. However, they did build a very large plant in Pennsylvania, known as the Atlantic Portland Cement Company. The foundations and partly completed buildings of this plant, together with much of the machinery, were subsequently sold under bond-holders' sale and purchased by the Her-

cules Portland Cement Company now in operation there. After the financial failure of the Dingee-Bachman cement syndicate, the Santa Cruz and Standard works were purchased by the Crocker-Cameron banking interests of San Francisco.

William G. Henshaw, a banker of Oakland, California, had been interested in the early nineties in some of the Pacific works, and in 1909 built one of the most successful plants on the Pacific coast, at Riverside in southern California. An interesting fact in connection with this plant is that the mill, which was located in territory filled with orange, lemon and other fruit trees, became involved in litigation growing out of an alleged dust nuisance produced in its manufacturing operations. This dust, it was alleged, discolored and injured the fruit, and after a long litigation the case was settled and the dust nuisance was abated to a large degree by the use of the Cottrell process for potash recovery, which not only prevented the dust from doing damage to the surrounding property, but produced a large revenue for the plant from the sale of the potash. As a side-light, it may be stated that after the Riverside Company had purchased many of the orange groves and other outlying farm lands, and the products of all these purchases, in the shape of fruits and vegetables of various kinds, took all the prizes at the State Agricultural Fair, it was proved that cement dust, especially that which contains potash, is not a detriment but rather a benefit to vegetation.

Mr. Henshaw died March 2, 1924. At that time he was president of the Riverside Portland Cement Company and the Golden State Portland Cement Company.

In his death, California lost one of its foremost upbuilders. In addition to being interested in the manufacture of cement, he was actively identified with banking, salt, oil, mining and land development interests. To all of these enterprises he brought keen judgment and rare ability. He enjoyed the enviable reputation of having had no business failure to mark his long career. His greatest and most valuable contribution to the state of California, which he loved so well, was the last one he made, namely, impounding and distributing water over the semi-arid county of San Diego. He lived to see this crowning effort attain success.

About 1911, operations were begun by Mr. Ladd, a banker of Portland, Oregon, and some New York capitalists in connection with the construction of a plant at San Juan, California. This plant was not finished until 1918, but was finally reorganized and is now in successful operation.

In 1907 the Cowell Lime & Cement Company, who were large dealers and manufacturers of lime and importers of portland cement from Europe, organized a works in California which is now in successful operation.

City of Los Angeles Undertakes Manufacture of Portland Cement

Another works was constructed in 1909 by the Los Angeles Aqueduct Commission of the City of Los Angeles. It was an experiment in municipal ownership. When the Aqueduct Commission called for bids on something like a million barrels of cement, manufacturers on the Coast quoted a figure regarded as too high. The engineers of the Commission then built a municipal plant, which has since been taken over by and is now operated by the Monolith Portland Cement Company.

In 1910 a plant was established on the Mohave Desert by the Golden State Portland Cement Company, and in 1911 the Inland Portland Cement Company, a subsidiary of the Lehigh Portland Cement Company of Pennsylvania, began operations at Metaline Falls, Washington, north of Spokane.

The first plant in Washington of which there is record was built in 1905 by A. F. Coats, a business man of Seattle.

Another plant was that of the International Portland Cement Company, located at Irvin, Washington, with an annual capacity of about 500,000 barrels, of which C. A. Irvin, now interested in the Alpha works, was the general manager and successful operator.

When American manufacturers by reason of their increased output had made it unprofitable to import European cement to the Pacific Coast, the great importing firm of Balfour, Guthrie & Company, of San Francisco, who had been largely interested as importers, built their own plant, with a capacity of 600,000 barrels, at Bellingham, Washington.

Two other works were built on the northwestern Pacific Coast, those of the Superior Portland Cement Company, of Concrete, Washington, with a capacity of 1,600,000 barrels per annum, which was organized in 1906, and the Oregon Portland Cement Company of Oswego, Oregon, with a capacity of 350,000 barrels, organized in 1915. The latter plant had for its president R. P. Butchart, one of the well-known Butchart family so largely interested in cement plants in the Rocky Mountain region and the Far Western states.

At Victorville, California, a large plant was erected by the Southwestern Portland Cement Company, which owned the plant at El Paso, Texas. Charles Leonardt, of Los Angeles, long connected with artificial stone works and with the scientific side of portland cement, was the President, and Charles Boettcher of Denver, whose cement activities extended throughout the greater part of the Far West, was the Vice President.

Since 1884, when the single plant at Oregon City began operations with its 100 barrels per day capacity, the industry on the Pacific Coast

has witnessed a remarkable development. As early as 1913 there were 13 plants established, capitalized at about \$24,000,000, and having a combined output of nearly 39,000 barrels per day.

Over-production Threatened at an Early Date

Looking back, one can see that even as early as 1900, over-production existed in the portland cement industry, and that as a result, prices fell to figures almost below the cost of production.

An article by Frederick H. Lewis, the well-known portland cement engineer, published in *Mineral Industry* for 1901, contains the prediction that the day of the small mill with limited machinery and limited capital, was practically over and that the growth of the industry would be in the direction of large plants, with high-grade machinery, well officered and manned, and controlling raw materials in abundance. This prophecy, which was bound sooner or later to be realized, was at least a little early, as shown by the official returns of production, which indicated the following increases by years, as estimated by Dr. Charles S. McKenna in his article in *Mineral Industry* for 1902.

RATE OF INCREASE IN THE ANNUAL PRODUCTION OF PORTLAND CEMENT IN THE UNITED STATES (a)

Year	Production	Rate of Increase Over Previous Year	Rate of Increase Referred to 1894	Year	Production	Rate of Increase Over Previous Year	Rate of Increase Referred to 1894
	Bbl. of 400 Lb.	Per cent	Per cent		Bbl. of 400 Lb.	Per cent	Per cent
1894	611,229	.....	.....	1899	5,805,620	62.0	1,176.3
1895	749,059	22.5	22.5	1900	7,991,639	37.6	1,204.6
1896	1,577,283	110.5	158.0	1901	12,711,225	49.8	2,000.0
1897	2,430,903	54.0	297.7	1902	16,535,000	30.0	2,606.2
1898	3,584,586	47.4	486.5				

(a) 1894-1901, from *THE MINERAL INDUSTRY*, Vols. IV to X inclusive; 1902, estimated by Charles F. McKenna.

These figures from another viewpoint, seem even more remarkable. From 1897 to 1899, the production almost doubled. The production of 1901 was more than twice the production of 1899. Later figures show that the production of 1903 was almost double the production of 1901; the production of 1905 was half as much again as that of 1903; the production of 1906 was double that of 1903. With these staggering figures before the world, indicating the rapid and almost unbelievable growth of an industry, which, in the early eighties, seemed almost an exotic in our country, it was but natural that there should be a continuing inrush of new men and new money into the field, in some cases from logical sources and in others through the instrumentality of the promoter.

The childhood days of the industry may be described as those from 1880 to 1900, when the workers in the field were gradually upbuilding a reputation for the American product and slowly feeling their way to the type and character of machinery which could be most economically used. With the advent of the rotary kiln and the iron mill, plant construction became more standardized. The promotor and his engineer were able to duplicate existing plants, and in fact improve upon some of them, while, the reputation of American portland cement having been established, there was a constant and growing demand which it was possible for new mills to find early opportunity to supply.

In those days, many men from many fields became part of the industry, bringing into it their prejudices, sentiments, habits, and experiences acquired in other fields of manufacture and commerce. At this time there was little or no engineering or scientific knowledge in the management of the business. Youth had not yet had an opportunity to become sufficiently experienced to take part in shaping the destiny of the industry; consequently, during the early years of the twentieth century, both manufacturing and selling methods had not yet become thoroughly stabilized. It is true that railroad rates had become fixed under the rulings of the Interstate Commerce Commission and that cut prices and rebates which, in the early days, enabled cowpath billings and rebates to be made, had ceased, and it became more and more evident to the large interests then coming into the industry, that with a commodity such as cement, weighing nearly 400 pounds to the barrel, the question of distribution was a vital one. It was no longer possible to transport cement from the Lehigh district to Chicago or from the Pittsburgh region to Boston, any more than it was to do any other reckless or uneconomic business thing. The fact was gradually forcing itself into the minds of those largely interested, that, in a way, portland cement works resembled brickyards so far as deliveries in large cities were concerned, and that a location within easy and economic reach by rail or water, of great cement-using centers, was a necessary element of success. It was also clearly evident that the successful plant must be well located with reference to raw materials—coal, limestone and clay, and also to one or more lines of railroad or waterways.

Changes in the Scene of Production

In 1905, the supremacy of the Lehigh district as a manufacturing center began to disappear. From 72.6 per cent of the entire output, it had fallen to about 49 per cent in 1905, this being the first year to show a transference of the center of the industry. Conditions resembled very much those that had prevailed in the case of the imported cement from Europe. This cement found its market on the Atlantic coast, on the Gulf coast,

and had pushed its way practically across the continent. Little by little, with the advent of the American product, the foreign product had been driven out of one Western market after another until finally imports ceased.

In the growth of the American industry, almost a parallel existed. States like California, Kansas, North and South Dakota, Nebraska and Oklahoma, which in the early days were importers of cement from the Lehigh district and some of the states in the Middle West, gradually began to have works either within their own area or within close geographical reach, and little by little ceased to import cement from the Eastern



The east side of the Grant Park Municipal Stadium on the Lake front at Chicago is built entirely of concrete and faced with precast concrete stone. When the Stadium is completed, more than 100,000 people can be seated at one time.

works. This condition reduced the percentage of the Lehigh output as above stated, and has reduced it at the present time to less than 26 per cent of the total. While the output of cement was steadily increasing during this period and was only stationary for practically the year 1907, it is nevertheless true that prices were continually getting lower, due, doubtless, to the fact that many of the newcomers in the field had either faulty methods of cost accounting and therefore believed they were making cement cheaper than the fact, or had insufficient capital and were forced to sell cement below cost.

Consolidations or Grouping of Plants Begins

About this time, in order to meet some of the conditions noted as regarded plant locations, there began the system of grouping plants under a single management, in some cases the plants being located in an individual field, and in others being scattered over various parts of the country. In his book, "The Portland Cement Industry from a Financial Standpoint," Edwin C. Eckel refers to this, and mentions the following grouping as existing in the portland cement industry in 1908:

GROUPINGS IN THE PORTLAND CEMENT INDUSTRY IN THE UNITED STATES IN 1908

Names of Companies	Location of Plants
1. Alpha Portland Cement Company, Alpha, N. J. Martins Creek Portland Cement Company	Martins Creek, Pa. Martins Creek, Pa.
2. American Cement Company Central Cement Company Reliance Cement Company Tidewater Cement Company	Egypt, Pa. Egypt, Pa. Egypt, Pa. Norfolk, Va.
3. Atlas Portland Cement Company	Northampton, Pa. Hannibal, Mo.
4. Lehigh Portland Cement Company, Ormrod, Pa. Shenango Portland Cement Company	Wellston, Ohio Newcastle, Pa.
5. Nicholson or Iola Group: Iola Portland Cement Company United Kansas Portland Cement Company Kansas Portland Cement Company Independence Portland Cement Company Indian Portland Cement Company Dixie Portland Cement Company Iowa Portland Cement Company Texas Portland Cement Company	Iola, Kan. Iola, Kan. Independence, Kan. Neodesha, Kan. Copenhagen, Tenn. Des Moines, Ia. Dallas, Tex.
6. United States Steel Corporation Universal Portland Cement Company	Chicago, Ill. Buffington, Ind. Pittsburgh, Pa.
7. Dingee Group: Standard Portland Cement Company Santa Cruz Portland Cement Company Northwestern Portland Cement Company Atlantic Portland Cement Company Northampton Portland Cement Company Quaker Portland Cement Company	Napa Junction, Calif. Santa Cruz, Calif. Kendall, Wash. Stockertown, Pa. Stockertown, Pa. Sandts Eddy, Pa.
8. Cowham Group: Peninsular Portland Cement Company Southwestern States Portland Cement Company Western States Portland Cement Company Northwestern States Portland Cement Company	Cement City, Mich. Dallas, Tex. Independence, Kan. Mason City, Ia.
9. Sandusky Portland Cement Company	Bay Bridge, Ohio Dixon, Ill. Syracuse, Ind. York, Pa.

Name of Companies	Location of Plants
10. Cement Securities Company	
Portland Cement Company of Colorado.....	Florence, Colo.
Portland Cement Company of Utah.....	Salt Lake City, Utah
Union Portland Cement Company.....	Devil's Slide, Utah

Among the outstanding figures in the industry at this period were: A. F. Gerstell, of the Alpha Portland Cement Company; Robert W. Lesley, of the American Cement Company; J. Rogers Maxwell, of the Atlas Portland Cement Company; Col. H. C. Trexler and E. M. Young, of the Lehigh Portland Cement Company; E. R. Ackerman, of the Lawrence Cement Company; W. S. Mallory, of the Edison Portland Cement Company; George E. Nicholson, of the Iola Portland Cement Company; Edward M. Hagar, of the Universal Portland Cement Company; William J. Dingee, of the Standard Portland Cement Company; W. F. Cowham, of the Peninsular Portland Cement Company; S. B. Newberry, of the Sandusky Portland Cement Company; Charles Boettcher, of the Portland Cement Company of Colorado; and John B. Lober, of the Vulcanite Portland Cement Company.

While these leaders gave time and energy to the business end of their enterprise and did much to widen the market and spread the fame of American portland cement, they nevertheless were not lacking in foresight with reference to the scientific development of their manufacture and to the broadening of the field for the use of their product. Out of this point of view grew the Association of American Portland Cement Manufacturers, which was formed in September, 1902. This Association rapidly developed into an institution of science and service in the portland cement industry. Its work is fully described in Appendix A, containing the history of the Association and its surprising growth and wonderful work.

Early Patents and Threatened Litigation in Connection Therewith

Another subject which gave the early manufacturers much anxiety and trouble was that of patent suits brought and threatened under the Hurry and Seaman patents for the utilization of powdered coal in rotary kilns. Oil, the early fuel of the rotary kiln, had advanced in price to such a point as to be uneconomic, and the perfection of the coal burning processes developed by Hurry and Seaman, of the Atlas Company, had secured their general adoption in one form or another in the rotary kilns that were being built in all parts of the country.

Litigation was begun under the Hurry and Seaman patents about 1900. On this point the following is quoted from *Mineral Industry*, 1907:

Testimony was taken in all parts of the United States and Europe, and the most noted experts and manufacturers were called as witnesses. Six years were spent in preparation of the suit, and when the case was argued officers and attorneys of the lead-

ing companies crowded the court room at Scranton, Pennsylvania, where, in 1906, with the Alpha Portland Cement Company as defendant, and the Atlas Portland Cement Company as plaintiff, the case was brought to a final hearing. Before judgment was entered, however, five of the leading companies of the Lehigh district, including the defendant, came to terms with the Atlas Portland Cement Company and agreed to take out licenses recognizing the Hurry and Seaman patents, and to pay a substantial royalty.

The North American Portland Cement Company was organized in the latter part of 1906, with a capital stock of \$10,000,000, having among its purposes the acquiring from the Atlas Portland Cement Company of the Hurry and Seaman and other patents, and the licensing thereunder of portland cement manufacturers. During 1907 the North American Company was extremely active in prosecuting infringers of its patents and in acquiring other patents for the protection of its licensees.

Birth of the Larger Rotary Kiln

Another marked advance in the cement industry was due to Thomas A. Edison, who devised new kilns, together with several unique methods of fuel consumption. In particular, he designed and patented a rotary kiln 150 feet long, and 7 to 8 feet in diameter, having a daily capacity of from 700 to 1,000 barrels of cement. Until that time the largest kilns in use were 60 to 80 feet long and 5 to 6 feet in diameter, with a capacity of 200 to 300 barrels per day. The adoption of the long kiln by the portland cement industry in general, and the consequent infringement of the exclusive patents held by Edison covering it, proved to be a possible fertile source of litigation which was only recently terminated by the acquisition by the North American Company of the patents for long kilns, burners, and similar apparatus owned by Mr. Edison.

As a result of the threatened litigation in the trade by reason of the patents above referred to, and others under similar control, the Association of Licensed Cement Manufacturers was organized in New York on January 9, 1908, by the North American Portland Cement Company, the Atlas, the Alpha, American, Lehigh, Lawrence and Vulcanite Portland Cement Companies, and various other important companies in the East and West, including among others, the Dexter, Edison, Nazareth, Pennsylvania, Penn-Allen, and Catskill, all of which have secured licenses under the Hurry and Seaman, Edison, Carpenter and other patents controlled by the North American Company.

In an announcement published at the time the following statement was made by the Association:

It is understood that all existing and properly equipped cement plants will be granted licenses and admitted to membership. Infringers of the patents above referred to will be rigorously prosecuted.

Nearly 70 per cent of the output of the portland cement industry in this country is already represented by the Association, this being double the annual production in Great Britain, the pioneer portland cement manufacturing country, equal to the combined output of England and France, and in excess of that of Germany. * * * * *

The Association of Licensed Cement Manufacturers, with its facilities for tests and experiments, its investigation of mechanical and chemical problems, its establishment of standards of quality, and its assistance in obtaining proper shipping facilities and rates, is expected to be of great benefit to its members.

North American Company and Subsidiaries Advance Scientific and Engineering Standards

Much good work in the scientific and engineering fields was done by the North American Company and its associate companies, and considerable publicity was given to new fields for the use of cement. Some years later litigation in reference to the Hurry and Seaman and Edison patents having been decided adversely to the Atlas and North American companies, the latter corporation and the Association of Licensed Portland Cement Manufacturers ceased to function, and at a still later period was formally dissolved.

An Era of Record Low Prices

During the period of the existence of the North American Company the lowest prices that were ever known in the cement industry were practically in existence from year to year. Competition of the most reckless character was prevalent in many parts of the country, in some cases leading to the uneconomical practice of cross shipments of cement from the West to the East and from the East to the West, trains passing each other on the way to their respective destinations. Naturally, when prices per barrel in the Lehigh district declined to about 70 cents in 1911 and as low as 67 cents in 1912, there was a general condition of financial disaster prevalent throughout the entire industry, and as stated in the testimony before the Underwood Tariff Committee in Congress in 1913, failures and reorganizations of nearly 33 per cent of the industry occurred. From a business standpoint, and considered as an economic proposition, the cement industry was not a success, and it was evident that notwithstanding the great development and wider markets, there existed conditions of great and permanent danger to those whose capital, energy and vitality were invested therein. The necessity of broadening markets, of finding new uses for cement and of building up new fields for sales, was constantly before the trade.

Association of American Portland Cement Manufacturers Plays Its Part in Progress

Plodding slowly in its chosen field, that of science and service, was the Association of American Portland Cement Manufacturers, which, from its very humble beginnings in 1902, began to increase its field of usefulness on the scientific side of cement testing and manufacture, and in the great field of service to all those who desired information concerning existing and future uses of portland cement. This intensive work, carried on at first in the most modest way, gradually began to produce results, and year by year more and more inquiries for information and construction data came to the office of the Association, and more and more service was

given by its staff in looking to increased use of portland cement. So much growth did this organization have that in 1915 it was reorganized on a very much larger scale. Headquarters were transferred from Philadelphia to Chicago, and an enlarged field of endeavor was mapped out. Through the work of the Association large and important fields developed. At the same time a laboratory in connection with the Lewis Institute of Chicago was established, and engineering offices opened in various parts of the country to render immediate service to those desiring it. The purpose of the Lewis Institute Laboratory was to deal with all problems of cement and concrete, and through it many discoveries of the highest value have been made, all of them of the greatest use to the engineer and private user.

Intensive promotion on the part of the Association produced remarkable results. For example, it is recalled that around 1914 cement manufacturers were surprised and encouraged when it was reported that promotion of concrete roads would probably increase consumption some 4,000,000 or 5,000,000 barrels. But what vigorous campaigning in this field alone really meant was revealed in 1919, when it was reported that contracts for concrete roads had exceeded 50,000,000 square yards, which may be roughly translated into 5,000 miles of 18-foot roads requiring approximately 18,000,000 barrels of cement. What actually happened from year to year in road promotion from the time the Wayne County, Michigan, concrete road system first attracted national attention is shown by the following table. The figures show the square yards of concrete pavement awarded in the United States by years from 1909 to 1923, inclusive.

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED
IN THE UNITED STATES BY YEARS

Year Awarded	Roads	Streets	Alleys	Total
Prior to 1909.....	34,061	444,864	112,491	591,416
1909.....	32,626	325,158	86,825	444,609
1910.....	151,148	682,637	107,874	941,659
1911.....	291,077	1,011,440	136,674	1,439,191
1912.....	1,869,486	3,326,029	185,703	5,381,218
1913.....	3,339,185	3,946,219	308,365	7,593,769
1914.....	10,608,421	4,830,604	300,138	15,739,163
1915.....	12,050,909	5,933,879	612,921	18,597,709
1916.....	15,906,801	7,395,975	880,179	24,182,955
1917.....	15,333,087	5,238,062	1,200,030	21,771,179
1918.....	12,990,519	3,295,817	565,948	16,872,284
1919.....	41,335,342	11,086,419	1,038,173	53,459,934
1920.....	29,326,689	8,814,782	907,164	39,048,635
1921.....	43,862,503	10,695,548	1,606,085	56,164,136
1922.....	58,301,413	18,607,792	2,176,500	79,065,705
1923.....	50,893,999	24,385,497	2,658,276	77,937,772
TOTALS.....	296,327,266	110,020,722	12,903,346	419,251,334

The construction of concrete pavements in 1923 required approximately 29,000,000 barrels, or 21 per cent of the country's total output.

Edward N. Hines, Pioneer in Concrete Road Construction

The remarkable increase in concrete road construction from year to year, as shown by the foregoing table, should not be dismissed without reference to pioneer work in this field. Just as the ranks of the founders of the cement industry were recruited from farms and professional callings rather than manufacturing and scientific circles, so the first extended and systematic construction of concrete roads was begun by one whose faith in his project more than compensated for his lack of engineering knowledge.



Concrete was used in the construction of the forty-foot wide "Ideal Section" of the Lincoln Highway.

To Edward N. Hines, of Detroit, printer and publisher, and Chairman, Board of County Road Commissioners, Wayne County, Michigan, the cement industry and the country at large are indebted for persistent effort in behalf of concrete roads, a purpose carried out in the face of skepticism on the part of many manufacturers as well as trained engineers. The system of concrete roads built by Hines in Wayne County, Michigan, was the initial undertaking that put this type of highway on the map.

Since 1918 cement manufacturers have shared in the benefits from a large increase in construction work. In virtually all of this work there would be demanded cement for thoroughly standardized practices, but

where the Association has been of great value to its members in this field is represented by a largely increased percentage in the use of cement along new lines as applied to many forms of construction, in brief, growing two blades of grass where formerly there was but one. And concerning the future, especially in the East, the three greatest potential outlets are streets, small dwellings and miscellaneous uses for cement about the home and on the farm, essentially fields that only cooperative effort such as is represented by the Association could have developed successfully.

Among the manufacturers and members of the Association conspicuously identified with all this important work were John B. Lober, for many years President of the Association and President of the Vulcanite Portland Cement Company; S. B. Newberry, President of the Sandusky Cement Company; F. W. Kelley, President of the Helderberg Cement Company, now President of the Association; B. F. Affleck, Past President of the Association and President of the Universal Portland Cement Company, and L. T. Sunderland, Past President of the Association and President of the Ash Grove Lime and Portland Cement Company.

Production Falls Off for the First Time in Years

Just as the years from 1880 to 1900 may be described as the childhood of the industry, so may the period from 1900 to 1913 be described as the youth of the industry—a period of vigor, strength, and virility, and possibly some excesses—but nevertheless stable and promising in its results. It was Edwin C. Eckel who, in 1906, when production had reached approximately 47,000,000 barrels, predicted that before long must come a year when production would show a decline over the preceding one, and that when this occurred it would mark the passing of the youth of the industry and the beginning of the period of its maturity. Precisely this change took place. It occurred in 1914. The year 1913 had shown some 92,000,000 barrels as against approximately 83,000,000 in 1912; but in 1914 production had declined from the 1913 figures of 92,000,000 to about 88,000,000 barrels, or a decrease of about 4.20 per cent. This was the first decline since the industry began, and notwithstanding the fact that the situation was created largely by the beginning of the world war, undoubtedly matters had reached the stage when continued prosperity demanded increased consumption growing out of new uses of cement, for the uses established up to that period had not caught up with the capacity of the mills. This prediction was further verified in later years when the curve of production, instead of showing a steady rise, showed rise and fall from year to year. And it was more than a coincidence that the passing youth of the mere commercial side of the industry was largely superseded by the maturity of science and service in its later days.

Finally came the trying period of America's entry into war.

CHAPTER XIV

THE CEMENT INDUSTRY IN RELATION TO THE WAR

The status of the cement industry during the war was more clearly discerned from the seat of Government than from any other point of view, Washington being the place from which emanated controlling influences that considered the industry solely with relation to the needs of the nation in its effort to win the war. For that reason the following analysis of the situation during the war period is quoted from the reports of the United States Geological Survey for 1918:

The course of cement manufacture during the last five years affords an illustration of the way in which an industry of vital importance to the nation in war time can do its share and yet suffer depression as the result of conditions imposed by the war.

In an earlier bulletin it was pointed out that the cement industry in the United States enjoys absolute independence of foreign supplies of raw materials or manufacturing machinery and that the United States produces more portland cement than is consumed within the country. The raw materials are abundant and cheap, and manufacturing plants are well distributed throughout areas of notable consumption.

The military importance of cement can not be overestimated. It is used mostly as an ingredient in concrete, and concrete possesses great adaptability to a wide variety of uses. Besides being cheap, easily and quickly handled, sanitary, and durable, concrete is suitable for structures that are submerged as well as those in dry places, and all these characteristics taken together render it of great military importance. Among the military structures in which concrete is used are armories, barracks, roads, bridges, coast and interior fortifications, gun emplacements, trench linings, bomb-proof shelters, magazines for explosives, tunnels, retaining walls, sea walls, wharves, dry docks, water reservoirs, aqueducts, sewers, sewage-treatment works, incinerators, stables, floors, roofs, munition-factory buildings, warehouses, fuel-oil tanks, barges, ships, and structures in the interior of battleships.

Conditions During the War

The year 1914 witnessed the first recorded decrease in annual production of portland cement in the United States. The industry had experienced a remarkable growth during the preceding 10 years, and it was only natural that a slight check should come at this time. The average price per barrel in bulk at mills in 1914, 92.7 cents, represented a decrease of 7.8 cents from the average of 1913, and indeed the beginning of the war in Europe may be said to have marked a depression in the American cement industry from which only a temporary recovery was made during the whole period of the war.

The portland cement industry showed no noteworthy development in 1915, notwithstanding the greater activity in the metal industries. In view of the experiences of 1914, manufacturers exercised considerable caution, the result of which was a slight increase in the volume of shipments, a small decrease in the quantity of cement manufactured, and a considerable decrease in the stocks of cement on hand, all indicating a

correction of the tendency toward overproduction that had manifested itself at times during the preceding few years. The average price in 1915, 86 cents a barrel, represented a decrease of 6.7 cents a barrel below the price in 1914, and the estimated consumption of portland cement per capita in the United States was 0.83 barrel, compared with 0.77 barrel in 1914. The total production in 1915 represented about 66 per cent of the apparent actual manufacturing capacity, according to figures reported to the Geological Survey.

In 1916 the conditions were more satisfactory. At the beginning of the year the industry was already feeling the effects of the gradual revival of activity in construction work, and throughout the year mills in all parts of the United States were busy manufacturing and shipping cement at a rate greater than at any other time since 1913, although labor troubles and lack of freight cars operated as a handicap. Higher prices prevailed, averaging \$1.103 a barrel at the mills, and six new plants reported their first production in 1916, one each in California, Minnesota, New York, Oklahoma, Oregon and Texas. The plants in Oregon and Texas are close to tidewater. About 68 per cent of the cement-manufacturing capacity was employed during 1916.

As a result of increased business in 1916, stocks of portland cement were reduced below the normal, yet the reserve of more than 8,250,000 barrels on hand at the beginning of 1917 proved to be sufficient for emergencies. The consumption of portland cement per capita in 1916 was estimated at 0.89 barrel, the highest during the period of the war.

In 1917 the cement industry, in common with most other manufacturing industries, faced unusual conditions. The demand for cement was generally very good during the first five to eight months but showed a decided falling off during the remainder of the year. The strong demand in the early part of the year so greatly stimulated production that the quantity of finished cement of all kinds manufactured reached a total of more than 93,000,000 barrels—the largest production ever recorded, and yet only about 68 per cent of the manufacturing capacity was reported to have been employed. The total shipments, on the other hand, decreased, and the stocks increased accordingly. The consumption per capita in 1917 was estimated at 0.84 barrel. The average price of cement (\$1.354) represented an increase of 25 cents over the average for 1916, and although the net profits appear not to have been great, the effect of prices high enough to minimize the chances of loss and the absence of price cutting seem both to have stimulated production and to have encouraged the completion of three new mills and the resumption of operations at one mill that was idle in 1916.

The only step taken by the Government to insure an adequate supply of cement for military purposes and at the same time hold prices at fair figures was taken in co-operation with representatives of the cement industry in 1917, shortly after the entrance of the United States into the war, when the first scale of prices was fixed. It was furthermore agreed that the Government requirements should be distributed as evenly as possible among the cement mills tributary to the localities where the cement was needed.

The adverse effects on the cement industry of the entrance of the United States into the European war began to be generally felt after the middle of the year and consisted mainly in shortage of fuel, railroad cars, and labor, and in the lessened demand for cement in some districts resulting from the curtailment of building operations not essential to the war. The necessary railroad embargoes were far-reaching; they affected supplies of fuel and other raw materials and of machinery and mill supplies and also shipments of cement to so great an extent that some mills had to be closed temporarily on account of lack of storage capacity.

In 1918, as has already been stated, the production of cement was the lowest since 1909. The average per capita consumption was 0.64 barrel in 1918 and the manufacturing capacity utilized was about 51 per cent of the total. The military requirements of the

Government, amounting to about 11,000,000 barrels, were easily met by the producers, the commercial business was subnormal on account of curtailment in construction work, and exports suffered through lack of ships. The average price per barrel (\$1.596) represented nearly as large an increase as in 1917 and was the highest price realized in the last 20 years.

If the five years of the war are considered as a whole, the average annual production and shipments of portland cement each amounted to nearly 86,000,000 barrels—a quantity greater than the annual production of any year prior to 1913, but as compared with the average annual capacity of the mills for manufacturing cement during this period, which is conservatively estimated at about 130,000,000 barrels, it is seen that the cement industry was abnormally restrained. The lowest factory prices during the war were about 14 per cent less than the pre-war price of 1913, and the highest prices were nearly 59 per cent above the level of 1913. Wholesale market prices dropped correspondingly, but they also rose to greater excesses above the price of 1913, in some places recording advances of more than 110 per cent.

War Prices for Cement

The following was taken from "Government Control Over Prices," by Paul Willard Garrett, and published by the War Trade Board in co-operation with the War Industries Board, Bernard M. Baruch, Chairman:

Portland cement ranked next in importance to lumber as a war building material. Its use in armories, barracks, gun placements, trench linings, bomb-proof shelter, incinerators, munition factory buildings, warehouses, barges, and reinforced concrete ships gave cement prominence in the war program as early as April, 1917, and the congestion of Government orders at certain points along the Atlantic seaboard threatened to cause local shortages of cement and sharp rises in cement prices in the districts of heavy Government demand. The production of cement for the country as a whole was ample for the increased requirements of war even without drawing upon the excess productive capacity of the cement mills. In fact the declining consumption of cement that resulted from the curtailment of normal building operations had more than offset the new orders from the Government. Since portland cement is a bulky commodity, however, it is not profitable to ship it far from the mill, and since the limestone and coal that are the chief materials used in its manufacture are widely distributed throughout the United States conditions have been favorable for the establishment of cement mills in nearly every state. Each cement mill thus enjoys a local monopoly, the radius of which is determined by its cost of production and by the proximity to other mills. The cement mills of the South, which possess an abundant supply of a limestone almost ideal for cement making, joined to a cheap supply of coal, can produce cheaper and send their product farther than the mills near New York City, which possess fewer advantages in respect to raw materials. Nevertheless the proximity to the great centers of population enables the mills in New York and the Lehigh district in Pennsylvania to offset the advantage of the Southern mills and allows them to hold the markets in the big cities against their Southern rivals. Thus the cement industry is split up into many local markets which are connected by a series of price differentials, but which nevertheless enjoy a large measure of independence. It is, therefore, possible for local shortages of cement to exist in some communities, notwithstanding the existence of an oversupply in other communities, and this is particularly true when the tremendous concentration of war goods, pouring towards the Atlantic seaboard, strained the normal means of transportation

and put an embargo on bulky goods. To secure an adequate supply of cement for the Government it was, therefore, necessary to allocate the supply and to fix the prices at the points of congestion.

The portland cement industry had a large degree of cohesion before the war for the purpose of pushing the sale of cement in competition with lumber, brick, and stone, although the price competition between the various cement mills had bordered on the cut-throat variety.

This organization nevertheless facilitated the quick appointment of a "cooperative committee on cement" under the Council of National Defense on April 21, 1917. This committee, composed of representatives of the industry and of the Government, at once began to act as a clearing house for assembling trade information preparatory to advising the committee on raw materials of the Council of National Defense as to available supplies and prices of cement. While this committee was acting, many purchases of cement were made by the Army and Navy at no definite price, but with the understanding that a fair price was to be fixed later. On December 18, 1917, the first committee was dissolved and a war service committee on portland cement was organized. No prices were fixed, however, until the price-fixing committee in April and May, 1918, after an investigation of costs by the Federal Trade Commission fixed prices for the Army and Navy purchases for the six months' period ending December 31, 1917, the four-month period ending April 30, 1918, and the four-month period ending August 31, 1918. Later on, August 23, 1918, the price-fixing committee established prices for the four months ending December 31, 1918. The prices set for 1917 applied only to Army and Navy purchases, and they became effective when accepted by the industry and the purchasing departments. This first price list, which has a retroactive effect, covered 30 different producing points, and the prices varied from \$1.30 a barrel in Texas to \$1.90 a barrel in California. The second price list applying to all Government purchases for the first four months of 1918 was the same as the first. The third set of fixed prices for the four months ending August 31, 1918, marked an advance of as high as 45 cents a barrel for the low-cost mills, dropped prices on some of the high-cost mills in the Pacific Coast states, and reduced the maximum variation in cement prices to 35 cents a barrel and the average variation to about 20 cents a barrel. The fourth price list for the four months ending December 31 was virtually the same as the third price list, except that the prices did not include bin inspection, and a reduction of 3 cents a barrel was made for the value of that service.

The chief results of the price fixing of cement were to prevent a rise in price at a few congested points along the Atlantic seaboard and to facilitate the prompt delivery of cement on Government orders by eliminating price cutting with its attendant waste, confusion, and irregular production. The main current of cement prices throughout the country as a whole was not substantially affected. Only 11,813,076 barrels of cement were allocated at this fixed price during 1917 and 1918, out of a total production of 92,814,202 barrels in 1917 and 71,632,000 barrels in 1918.

The price of portland cement to the general public was never fixed, and this ranged about 30 cents a barrel higher than the price fixed to the Government. Price fixing leveled up market prices to some extent, thereby giving the low-cost mills large profits, while limiting the marginal mills to a low return. The concentration of production at the largest mills equipped with the most modern machinery would have enabled the Government to have fixed cement prices at a lower level, but the pooling necessary to bring this about involved too many practical administrative difficulties to justify the adoption of this policy. The prices fixed in 1917 yielded the cement industry as a whole 12 per cent on its investment, and of course individual mills reaped a much higher rate, but subsequent price fixing reduced this margin to 6 per cent merely by maintaining

the status quo in the face of advancing costs. The general supply of cement was so ample, as compared with needs, that the Fuel Administration on April 13, 1918, reduced the fuel allotment of the cement mills to 75 per cent of normal on the theory that part of the fuel used in the cement industry could be better employed in other war industries. There was, consequently, no occasion for stimulating cement production by high prices, and the lowering of the margin of profit for the purpose of curtailing production was entirely justified. Cement prices rose in the open market less than any other basic building material during the war, and the reason for price fixing in the field of cement is to be found in the desire of the Government to prevent the stimulation of prices which its own large demand would normally have caused in certain congested building areas.

Effect of War on Original Groupings of Companies

Efforts of the Government to obtain maximum efficiency in the manufacture and distribution of cement during the war had its effect upon the industry by enlarging the field of some of the groups already referred to, so that at the close of hostilities there remained of the original groupings five large groups as follows:

Lehigh Portland Cement Company, with fifteen works consisting of three mills at Orinrod, Pennsylvania; one at West Coplay, Pennsylvania; one at Fogelsville, Pennsylvania; three at New Castle, Pennsylvania; two at Mitchell, Indiana; one at Fordwick, Virginia; one at Mason City, Iowa; one at Oglesby, Illinois; one at Iola, Kansas; and one at Metaline Falls, Washington; these plants being distributed all over the country at places where good materials, fuel, and accessible markets were found.

The Atlas Portland Cement Company, with plants at Coplay and Northampton, in Pennsylvania; Hannibal, Missouri; Hudson, New York; and Leeds, Alabama.

The Sandusky Cement Company, with plants at Bay Bridge, Ohio; Syracuse, Indiana; Dixon, Illinois; and York, Pennsylvania.

The Alpha Portland Cement Company, with plants at Alpha, New Jersey; Martins Creek, Pennsylvania; Manheim, West Virginia; Cementon and Jamesville, New York; Bellevue, Michigan; La Salle, Illinois; and Ironton, Ohio.

The Universal Portland Cement Company, with plants at Buffington, Indiana; Universal, Pennsylvania; and Duluth, Minnesota.

Of the original groups there ceased to exist the Nicholson or Iola group, the Dingee-Bachman group, the American Cement Company group, and the Cowham group.

The handling of materials during the war was a great lesson to all manufacturers as to the necessity of delivering from the nearest mill to the point of use, and this practice has led to the formation of the groups referred to and is likely to have a continuing effect upon the industry.

The Portland Cement Association celebrated in November, 1922, the 20th anniversary of its formation, and that it was proper for the pioneers

in the industry to take pride in their achievements in its behalf is shown by the following contribution to the occasion by Robert W. Lesley, first President of the Association:

In assisting at the 20th anniversary of the formation of the Portland Cement Association, it is certainly permissible for the veterans who took part in the early days of the organization to refer to some of the conditions governing our Association in its formative period and at the present time. The great and remarkable fact is that a gathering of men, all intent upon the money-making side of their business and establishing against a firmly entrenched foreign competition of an American industry, met in the furtherance of their business interests upon a call to deal with "the present methods of handling the subject of sacks, which are almost universally unsatisfactory"; and that out of the meeting called to deal with this strictly business and money-making proposition grew the great scientific and altruistic organization now known as the Portland Cement Association.

The pioneers who took part in these early meetings may be compared to sculptors. They had the raw material in the block, men energetic, full of enterprise, vitality, and some touch of selfishness, who had gathered together from many other fields and businesses and were imbued with the thought of making a success in their new and chosen enterprise. Out of this raw material these sculptors, twenty years ago, blocked out in the rough the statue which in its perfection, its details, and its growth represent a great scientific and altruistic development of business enterprise, with ample funds and scientific knowledge, devoted not only to the development of the cement industry itself but to the service of consumers, buyers, engineers, the scientific world at large, in fact all who have to do with the great construction work of our country.

Looking back to this early period, as shown by the proceedings of the early meetings of our Association, it will be found that almost every field of development, to which in its perfected form our Association is now devoted, had its inception in the minds of that little band of twenty-odd men who formed the Eastern Portland Cement Association away back in 1902.

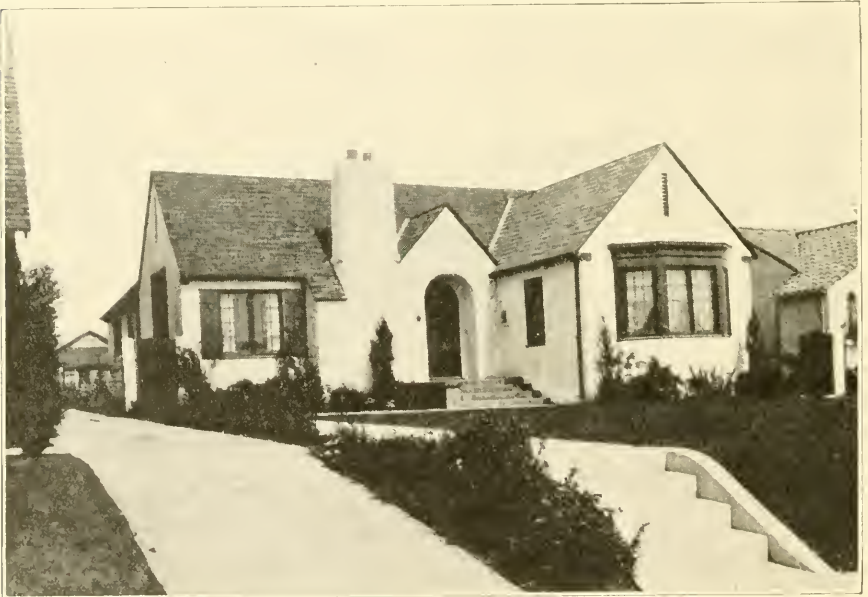
The character of the work of the Association was such that before twelve months had passed since it had been formed it was working in cooperation with scientific bodies of the highest standard, such as the American Society for Testing Materials, the American Society of Civil Engineers, the Institute of Architects, iron and steel associations, the Railway Maintenance Association, and even the Government of the United States. It was given the rare distinction seldom if ever bestowed upon a business organization, namely, that of participating with the leading engineering societies as a member in all committees having to do with specifications for portland cement and concrete. This was due largely to the character and scientific knowledge of the men representing the Association in the various technical committees and the high character of the scientific papers read before the Association.

At the conclusion of the first year after the Association's founding, its membership represented 90 per cent of the total output of portland cement, then some 22,000,000 barrels; and the United States then had 45 concerns producing over 20,000,000 barrels of cement, against a like production by some 96 associated concerns in Germany, the leading European producer of the material. Though, as was entirely natural, the United States had gone into the industry with the dollar taking precedence over scientific achievement, yet, nevertheless, the American Association had, in a single year of its existence, enlisted the cooperation of all the leading American scientific bodies, whereas the Germans had been organized fifteen years before they were able to accomplish like results.

This recognition of the Association in its early days by the leading engineering organizations in the United States was well described in an editorial in *The Engineering Record* in 1903, then one of the important engineering publications in the United States, which, in commenting on the first year's work of the Association, stated:

"The Association work is something for which the engineering profession has reason to be grateful. The old idea that the manufacturer of materials of construction is the enemy of the engineer falls to the ground in the face of such a record. In its one year of usefulness this manufacturers' organization has done more to advance sound masonry construction than all other societies together."

In summing up, the engineer-editor said that the Association "had brought producer and manufacturer together, furnished facilities for elaborate investigations and shown itself ready to cooperate in every way to further the real interests of sound masonry construction."



A cozy home of concrete and portland cement stucco at Hollywood, California.

It was during this first year that the organization known as the Eastern Manufacturers of Portland Cement took on a national character, when on March 10, 1903, it was joined by the representatives of the Central Cement Association, then consisting largely of manufacturers in the West and Middle West. With this addition, the membership had now grown to forty-six companies, representing manufacturers from the Atlantic to the Pacific coasts and producing from 90 to 95 per cent of the total output of the United States.

By this time the rough stone in the block had begun to take shape, and a comparison of today's activities of our great Association will show that the statue blocked out twenty years ago by the early pioneers had most, if not all, of the outlines and members of the great and beautiful statue since developed by our organization.

In brief, then, the Association in its early days represents what it now stands for, namely, concerted effort in behalf of the industry, as distinguished from individual endeavor. After its foundation it soon became the forum or clearing-house for the sifting of facts calculated to be of value to the individual manufacturer in the operation of his plant. It revealed the importance of the industry as a great national asset, thereby stimulating confidence in its future. As a body, it was more concerned in the proper and economic uses of cement than the prices thereof, thus putting the industry as a whole on a very high plane insofar as its relations to the engineering profession and the public were concerned. It taught the people at large how to use cement for countless purposes of which they had no previous knowledge, something no individual concern could have accomplished.

The Association became the official representative of the industry before technical and scientific bodies. It had appeared on the platform and written textbooks. And in all this work, it has been as though its engineers, experts and other agents were working for a single manufacturer, for each has been entitled to the full benefits thereof.

Therefore, in looking back as a participant in all the activities of the Association from the day of its founding until today, and having an equally intimate and practical knowledge of the industry during the years preceding the forming of the Association, I feel that its organization was, in a sense, the establishment of progress in the industry, entailing no sacrifice of individual initiative or enterprise such as obtained in the earlier period when each was a law unto himself, and producing instead of haphazard work of divided effort, concentrated, definite, altruistic service for consumer, contractor and engineer.



APPENDIX A

HISTORY OF THE PORTLAND CEMENT ASSOCIATION

No history of the portland cement industry in America would be complete unless supplemented by a history of the Portland Cement Association. And although portland cement attained its hundredth birthday in 1924, it has been during the past twenty-two years, which period marks the life of the Portland Cement Association, that the industry in America secured its foothold and rose to the present eminent place among outstanding American industries.

In 1902, the year in which the parent organization of the Portland Cement Association was formed, the production of portland cement in the United States, according to figures of the U. S. Geological Survey, was 17,230,644 barrels. In 1923, according to figures from the same source, production reached 137,377,000 barrels.

Among the factors which unquestionably have contributed to the progress which the foregoing figures illustrate, is the educational work of the Portland Cement Association.

To make it easier for the reader to associate growth of the industry with the activities of this Association as its history will be unfolded in the following pages, a brief summary of the objects and aims of the Association may well be presented now.

There are probably few who have not at some time heard of the work of this Association of pioneer manufacturers. For convenience, it may be included in that large group commonly called "trade" associations. It is unfortunate, however, that many speak of the Portland Cement Association as a trade organization without further explanation. This causes frequent comparison of the Association with other groups of manufacturers, which, though in many instances similar, are quite different.

Fundamentally, the Portland Cement Association is a service organization. It is not incorporated and not a commercial body in the ordinary sense of the word. Membership is purely voluntary and its scheme of organization and policies is thoroughly democratic. Each member, without reference to size, has but one vote in helping to establish and promote its policies.

Having nothing to do with the manufacture, sale or distribution of cement, the Portland Cement Association can concern itself strictly with the educational-research work for which it primarily exists.

Present Members of Portland Cement Association

The financial resources of the Association are dues obtained from its membership. At the present writing the membership is as follows:

Aetna Portland Cement Company.....	Detroit, Mich.
Allentown Portland Cement Company.....	Allentown, Pa.
Alpha Portland Cement Company.....	Easton, Pa.
Ash Grove Lime & Portland Cement Company.....	Kansas City, Mo.
Atlas Portland Cement Company, The.....	New York, N. Y.
Bath Portland Cement Company.....	Philadelphia, Pa.
Beaver Portland Cement Company.....	Portland, Ore.
Bessemer Limestone and Cement Company.....	Youngstown, Ohio
British Columbia Cement Company, Ltd.....	Victoria, B. C., Can.
Canada Cement Company, Ltd.....	Montreal, Que., Can.
Clinchfield Portland Cement Corporation.....	Kingsport, Tenn.
Colorado Portland Cement Company.....	Denver, Colo.
Cowell Portland Cement Company.....	San Francisco, Calif.
Crescent Portland Cement Company.....	Wampum, Pa.
Dewey Portland Cement Company.....	Kansas City, Mo.
Dexter Portland Cement Company.....	Nazareth, Pa.
Diamond Portland Cement Company, The.....	Cleveland, Ohio
Dixie Portland Cement Company.....	Chattanooga, Tenn.
Edison Portland Cement Company.....	New York, N. Y.
Giant Portland Cement Company.....	Philadelphia, Pa.
Gilmore Portland Cement Corporation.....	Gilmore City, Ia.
Glens Falls Portland Cement Company, The.....	Glens Falls, N. Y.
Golden State Portland Cement Company.....	Los Angeles, Calif.
Great Western Portland Cement Company, The.....	Kansas City, Mo.
Gulf States Portland Cement Company, The.....	Demopolis, Ala.
Hawkeye Portland Cement Company.....	Des Moines, Ia.
Helderberg Cement Company, The.....	Albany, N. Y.
Hercules Cement Corporation.....	Philadelphia, Pa.
Hermitage Portland Cement Company.....	Nashville, Tenn.
Huron Portland Cement Company.....	Detroit, Mich.
Indiana Portland Cement Company.....	Indianapolis, Ind.
International Cement Corporation.....	New York, N. Y.
International Portland Cement Company, Ltd.....	Spokane, Wash.
Kansas Portland Cement Company, The.....	Kansas City, Mo.
Knickerbocker Portland Cement Company, Inc.....	Albany, N. Y.
Kosmos Portland Cement Company.....	Jefferson Co., Ky.
"La Tolteca," Cia. de Cemento Portland, S. A., Independencia No. 8.....	Mexico City, D. F. Mexico
Lawrence Portland Cement Company.....	Siegfried, Pa.
Lehigh Portland Cement Company.....	Allentown, Pa.
Louisville Cement Company.....	Louisville, Ky.
Manitowoc Portland Cement Company.....	Manitowoc, Wis.
Marlboro Cement Company.....	Edmonton, Alta., Can.
Marquette Cement Manufacturing Company.....	Chicago, Ill.
Missouri Portland Cement Company.....	St. Louis, Mo.
Monarch Cement Company, The.....	Humboldt, Kans.

Monolith Portland Cement Company.....	Los Angeles, Calif.
National Cement Company.....	Birmingham, Ala.
Nazareth Cement Company.....	Nazareth, Pa.
Nebraska Cement Company.....	Denver, Colo.
Newaygo Portland Cement Company.....	Newaygo, Mich.
New Egyptian Portland Cement Company.....	Detroit, Mich.
Northwestern States Portland Cement Company.....	Mason City, Ia.
Ogden Portland Cement Company, The.....	Ogden, Utah.
Oklahoma Portland Cement Company.....	Denver, Colo.
Olympic Portland Cement Company, Ltd., The.....	Seattle, Wash.
Oregon Portland Cement Company.....	Portland, Ore.
Pacific Portland Cement Company, Consolidated.....	San Francisco, Calif.
Peerless Portland Cement Company.....	Detroit, Mich.
Peninsular Portland Cement Company.....	Cement City, Mich.
Penn-Allen Cement Company.....	Allentown, Pa.
Pennsylvania Cement Company.....	New York, N. Y.
Petoskey Portland Cement Company.....	Petoskey, Mich.
Phoenix Portland Cement Company.....	Philadelphia, Pa.
Pittsburgh Plate Glass Company, Columbia Chemical Division, Limestone Products Department.....	Zanesville, Ohio
Portland Cement Company of Utah.....	Salt Lake City, Utah
Pyramid Portland Cement Company.....	Des Moines, Ia.
Riverside Portland Cement Company.....	Riverside, Calif.
San Antonio Portland Cement Company.....	San Antonio, Tex.
Sandusky Cement Company.....	Cleveland, Ohio
Santa Cruz Portland Cement Company.....	San Francisco, Calif.
Security Cement & Lime Company.....	Hagerstown, Md.
Signal Mountain Portland Cement Company.....	Chattanooga, Tenn.
Southern States Portland Cement Company.....	Rockmart, Ga.
Southwestern Portland Cement Company.....	Los Angeles, Calif.
St. Mary's Cement Company, Ltd.....	Toronto, Ont., Can.
Sun Portland Cement Company.....	Portland, Ore.
Superior Portland Cement Company.....	Seattle, Wash.
Texas Portland Cement Company.....	Dallas, Tex.
Three Forks Portland Cement Company.....	Denver, Colo.
Tidewater Portland Cement Company.....	Baltimore, Md.
Trinity Portland Cement Company.....	Dallas, Tex.
Union Portland Cement Company.....	Denver, Colo.
United States Portland Cement Company.....	Denver, Colo.
Universal Portland Cement Company.....	Chicago, Ill.
Vulcanite Portland Cement Company.....	Philadelphia, Pa.
Wabash Portland Cement Company.....	Detroit, Mich.
Wolverine Portland Cement Company.....	Coldwater, Mich.
Wyandotte Portland Cement Company.....	Detroit, Mich.

Membership Extends Beyond Borders of United States

Although one of the slogans of the Association describes it as, "A National Organization to Improve and Extend the Uses of Concrete," it will be seen from the above list of members that cement manufacturing companies in Canada, Cuba, Mexico and South America constitute its

personnel, so that in a sense its scope is more than national. However, members outside of the United States proper are considered in the Constitution and By-Laws under the classification "foreign" and do not subscribe to the work of the Association at the same rate of dues as domestic members since the major activities of the Association are carried on strictly within the borders of the United States.

General and District Office Organization

The national headquarters of the Association are in the Conway Building, 111 West Washington Street, Chicago. In addition, there are District Offices in the following cities:

Atlanta	Jacksonville	Parkersburg
Birmingham	Kansas City	Philadelphia
Boston	Los Angeles	Pittsburgh
Charlotte, N. C.	Memphis	Portland, Oreg.
Chicago	Milwaukee	Salt Lake City
Dallas	Minneapolis	San Francisco
Denver	New Orleans	Seattle
Des Moines	New York	St. Louis
Detroit	Oklahoma City	Vancouver, B. C.
Indianapolis		Washington, D. C.

District offices are primarily service stations of the organization and have been established as a consequence of need made evident by the growing demand for reliable information on the many applications of concrete. Their convenient location makes them time savers for those who want full and dependable information quickly.

The headquarters of the Association, referred to as the "General Office," is departmentized so that various classes of educational-research work in the interest of concrete and its uses and the dissemination of the resulting information are done by these several departments.

For example, the Highways Bureau consults and advises with those interested in the permanent improvement of roads, streets, alleys or other thoroughfares which may require paving. This bureau gives helpful advice on the preparation of special specifications or the adaptation of existing ones, to officials or others having to do with highway improvement.

The Structural Bureau, another one of the headquarters departments, renders consulting, advisory service to engineers, contractors, architects or others by suggesting or recommending ways and means of using concrete effectively for any structural purpose other than roads, streets and alleys, except as noted later. Anyone familiar with the breadth of meaning of the term "building construction" can readily see that the service which the Structural Bureau must be prepared to offer is almost limitless.

Yet the work of this bureau does not encroach upon the field which might be called "farm" structures. In that particular field the Cement

Products Bureau, somewhat misleadingly named, functions. It is perhaps difficult for the outsider to associate this department with the many promotional activities in which it engages to improve and extend the use of concrete. Within itself, the Cement Products Bureau is departmentized. It has a personnel of specialists in farm structures, sewer work, drainage, the manufacture of such concrete units as building block, concrete brick and concrete structural tile, telegraph and telephone poles, fence posts, lighting standards, precast concrete stone for architectural trim, concrete sewer and culvert pipe. It also comprises a section devoted to concrete house promotion, although naturally work in this particular field calls in participation of the Structural Bureau.

The fund of information which the Portland Cement Association has accumulated is of almost inestimable value because of the research work done by the Structural Materials Research Laboratory, Chicago. This laboratory is operated jointly by, and in cooperation with, the Lewis Institute. It is under the immediate charge of Duff A. Abrams, one of the most prominent research workers in the country, whose studies in concrete are generally conceded preeminent. The extensive research and the resultant disclosures from the many years of experiments carried on in the Structural Materials Research Laboratory, have established as facts the valuable information which is the Portland Cement Association's stock-in-trade, and which is furnished to those interested in making the most practical applications. In no other laboratory in the world have there been, or are there being conducted, such numerous and exhaustive tests on the properties of cement and concrete, leading to a thorough understanding of these materials from the viewpoint of their adaptability to certain structural requirements.

Other departments at Association headquarters are:

Administrative

Auditing

Purchasing

Advertising and Publications

Accident Prevention and Insurance

Railways

Conservation

General Educational

Library

The purposes of these several bureaus and departments are suggested by their names. Their particular functions as may be necessary to elaborate upon will be referred to later.

From the foregoing, the reader will have discerned that the Association's activities are coextensive with, but nevertheless confined within, the following limitations:

(1). Its aim is to increase the knowledge, utility, and use of portland cement through scientific investigation, public education, and associated promotion.

(2). It "sells" the idea "concrete for permanence"; in other words, the use of cement, but not the commodity. Therefore it is not concerned in the brand of cement used.

(3). It performs only such functions as cannot as well, if at all, be performed by its members individually.

(4). It undertakes only such activities as are for the common good and whose benefits when taken advantage of, accrue alike to all contributing members.

(5). Its conduct is jealously guarded and made to conform scrupulously in all respects to the highest concept of commercial morality and the strictest interpretation of the laws of the land.

To conform with these precepts makes it evidently impossible for the Association to engage in any attempt to solve individual manufacturing problems of its members except where the nature of such problems is such as to invest them with common interest so that their solution would either directly benefit all alike or otherwise protect the whole industry against unfavorable reaction that likely would result from their neglect.

The Association, with its successful blending of the self-interested and altruistic interests of its members, is unique. It has no counterpart in American industrial history.

Every phase of Association work is well considered and none lacks importance. Each activity engaged in represents a crystallization of the widest experience and most constructive thought of the industry. This will be made more evident in what follows, as its early history and growth are unfolded.

How the Portland Cement Association Came to Be Formed

After reading the preceding chapter, it may seem somewhat incredible that an organization of the kind described should have had its inception in a little incident far removed from any thought of the possibilities of concrete as a building material.

In 1902 a group of eastern cement manufacturers, intent as are all earnest business men upon the money making side of their business and in establishing an American industry as against a firmly entrenched foreign competition, responded to a call for a meeting issued by one of their number to discuss and find a solution, if possible, for "the present methods of handling the subject of sacks, which are almost universally unsatisfactory." Out of the meeting called to deal with this strictly commercial proposition grew the great scientific and altruistic organization now known as the Portland Cement Association. But that is getting ahead of the story.

Everyone knows that cement is shipped almost universally in cloth sacks. Few people outside of the industry, however, know what a lot of trouble the cement sack, or rather the handling of it as between purchasers of cement and the repurchase of sacks by the manufacturer, has caused during the past twenty years.

So in response to the pressure of a common interest, the call, shown in facsimile on page 198, was issued for a get-together on the "sack question."

In response to the circular letter embodying this call, which was issued by B. F. Stradley, General Sales Agent of the Vulcanite Portland Cement Company, dated September 4, 1902, the following named representatives convened:

Lehigh Portland Cement Company, C. A. Matcham, Gen. Mgr.
 Bonneville Portland Cement Company, W. H. Harding, Pres.; Howard L. Schoch.
 Alpha Portland Cement Company, A. F. Gerstell, Vice Pres.; John B. Wight.
 Northampton Portland Cement Company, B. Sherwood Dunn, Pres.; H. S. Thompson, C. W. Lyon, Edmund H. Carhart.
 Coplay Cement Manufacturing Company, Thos. J. Brady, Pres.
 Phoenix Cement Company, Wm. Turner, Pres.; Jos. W. Zipperlein.
 Catskill Cement Company, J. W. Kittrell, Sec. and Treas.
 Dexter Portland Cement Company, Geo. E. Bartol, Pres.; Jos. Brobston, Sec. and Treas.
 Glens Falls Portland Cement Company, W. W. Maclay, Pres.; Byron Lapham.
 Cayuga Lake Cement Company, M. E. Calkins, Pres.
 Helderberg Cement Company, T. Henry Dumary, Pres.
 Vulcanite Portland Cement Company, Jno. B. Lober, Vice Pres.; B. F. Stradley;
 Geo. W. Elkins, Pres.
 American Cement Company, R. W. Lesley, Vice Pres.; Wallace King, Jr.
 Martins Creek Portland Cement Company, Geo. W. Roydhouse, Pres.; C. C. Murtha, Sec.
 Alsens Portland Cement Company, Mr. Barth; R. S. Sinclair.
 Lawrence Cement Company, Ernest R. Ackerman, Pres.; L. V. Clark, Jr.
 Nazareth Cement Company, P. H. Hampson, Treas. and Mgr.
 Atlas Portland Cement Company, H. W. Maxwell, Treas.
 Whitehall Portland Cement Company, W. B. Whitney, Treas.
 Edison Portland Cement Company, L. H. Carr.
 Empire Portland Cement Company, Chas. A. Lockhard, Mgr.
 Wayland Portland Cement Company, V. F. Whitmore, Pres.
 T. Millen & Company, O. Millen.
 Virginia Portland Cement Company, W. R. Warren, Pres.

As a preliminary, these gentlemen were invited to luncheon, at the conclusion of which Robert W. Lesley, of the American Cement Company, expressed on behalf of those present, appreciation for what the officers of the Vulcanite Portland Cement Company had done in bringing the group together. John B. Lober, then Vice President of the Vulcanite Portland Cement Company, responded, predicting a successful meeting because of the representative attendance, and suggested adjournment to

The undersigned, manufacturers of Portland Cement, recognizing the fact that the present methods of handling the subject of "sacks" are almost univereally unsatisfactory, and believing that the question can be profitably discussed and a satisfactory plan evolved at a meeting of the representatives of the Eastern Mills, hereby pledge themselves to attend such a meeting to be held at such time and place as may be most convenient to a majority of those signing.

LEHIGH PORTLAND CEMENT CO.

E. M. Young

THE VULCANITE PORTLAND CEMENT CO.

W. L. Shober VICE PRESIDENT

BONNEVILLE PORTLAND CEMENT CO.

W. H. Starding

ALPHA PORTLAND CEMENT CO.

*A. F. Entice V. Pr.*NORTHAMPTON PORTLAND CEMENT CO.
J. Allen

COPLEY CEMENT MANUFACTURING CO.

Wm. J. Brady Pres.

PHOENIX CEMENT COMPANY

Wm. J. Brady

CATSKILL CEMENT CO.

*J. Mitchell**Secy Treas.*

DEXTER PORTLAND CEMENT CO.

*George E. Doster**Pres.*

THE GLENS FALLS PORTLAND CEMENT CO.

W. W. Macay

President

CAYUGA LAKE CEMENT CO.

*McLeathins**H. B. Leathers**Thos. L. Linsley*

President

Ames and cement Co
Pres.

Martin's Creek Portland Cement Co.

Wm. J. House President*Simlan Babson*

Lawrence Cement Co.

Ernest R. Ackerman Pres.

NAZARETH CEMENT CO.

Wm. J. House

Atlas Portland Cement Co.

A. J. Howard

The Whitehall Portland Cement Co.

W. J. House

THE EDISON PORTLAND CEMENT CO.

W. J. House

Empire Portland Cement Co.

Chas. L. Linsley MANAGER

Wayland Portland Cement Co.

*V. F. Whitson**J. Miller & Co.*

the adjoining room and temporary organization for the purpose of proceeding with the business for which the group had assembled.

Upon reassembling, Mr. Lober expressed the opinion that it would be wise to proceed to a permanent organization. This resulted in the election of Robert W. Lesley, Chairman, and A. F. Gerstell, Vice President and General Manager of the Alpha Portland Cement Company, as Secretary.

The call for the meeting was read and the Chairman invited frank and free discussion of the subject referred to in the call.

The minutes of the first meeting show that the invitation of the Chairman was taken advantage of. Early in the proceedings, cognizance was taken of the fact that a number of companies were represented by several individuals and a precedent was established on motion of Mr. Lober that in any vote taken in the meeting, each company should have but one vote. This was unanimously adopted.

Following lengthy discussion, several resolutions were offered intended to govern the sale and return of empty sacks, the final one to be adopted being offered by G. W. Roydhouse, President of the Martins Creek Portland Cement Company, as follows:

WHEREAS, the Eastern Manufacturers of portland cement here assembled, are of the opinion that it would be greatly to the advantage of the Industry to organize a permanent association to meet at stated periods, for the purpose of discussing the various questions of interest to the trade, arising from time to time, and to exchange view, as to the best methods of extending and developing the business; therefore it is

RESOLVED, that a Committee of seven (7) manufacturers be appointed by the Chairman of this meeting to prepare a plan for such organization, said Committee to report at a subsequent meeting:

RESOLVED, that when this meeting adjourns it shall adjourn to meet again at the call of the Chairman at such time and place as he may designate.

The resolution was unanimously passed.

Among so-called "sack troubles" there existed in the early days some which still engage the attention of the industry. This is evidenced by B. S. Dunn calling attention at this first meeting to the fact that there had been considerable trouble experienced by the transportation companies in the return of empty sacks and that this trouble had reached such a point that the various railroads found it necessary to appoint a committee to take up this subject with several cement manufacturers.

On motion of G. E. Bartol, the following resolutions were adopted:

RESOLVED, that the Chairman appoint as a special committee a committee of five (5) to consider the bag question exclusively, and also to consider and take up with the railroad companies the subject of the return of empty bags.

On motion of W. R. Warren, it was

RESOLVED, that each Company present here shall report its views in writing on the "sack" question, and that these reports shall be sent to the Chairman of the meeting to be forwarded by him to the special committee before October 1, 1902.

On motion of W. H. Harding, it was

RESOLVED, that the proceedings or minutes of the meeting be printed, and a copy be sent to each of the representatives present, the cost of which printing should be equally borne by the several companies represented.

On motion of G. E. Bartol, a vote of thanks was extended to the officers of the Vulcanite Portland Cement Company for having been instrumental in bringing about this pleasant meeting, and one which gave promise to such happy results.

These proceedings concluded the first meeting.

As shown by the records of A. F. Gerstell, Secretary, the resolution leading to a permanent organization, as offered by G. W. Roydhouse, had been prepared in advance of the meeting by John B. Lober, who intended first to present it himself but later decided that it should be presented by Mr. Roydhouse. This is mentioned because to Mr. Lober's efforts, more than to those of any other individual, was due the call for the meeting just reported and the formation of a permanent organization which followed.

The second meeting of the Eastern Portland Cement Manufacturers, as the group unofficially seems to have called themselves, was held at Sherry's, New York, October 23, 1902. Representatives of twenty companies were present. Robert W. Lesley acted as presiding officer. A Constitution and By-Laws were adopted and officers were elected as follows:

- Robert W. Lesley, President,
American Cement Company.
- John B. Lober, Vice President,
Vulcanite Portland Cement Company.
- A. F. Gerstell, Secretary,
Alpha Portland Cement Company.
- E. M. Young, Treasurer,
Lehigh Portland Cement Company.

An Executive Committee was also elected, consisting of the following:

- H. W. Maxwell,
Atlas Portland Cement Company.
- W. R. Warren,
Virginia Portland Cement Company.
- E. R. Ackerman,
Lawrence Cement Company.
- W. W. Maclay,
Glens Falls Portland Cement Company.
- T. H. Dumary,
Helderberg Cement Company.
- W. H. Harding,
Bonneville Portland Cement Company.
- G. E. Bartol,
Dexter Portland Cement Company

A Nominating Committee was appointed, consisting of:

W. H. Harding
T. H. Dumary
John B. Lober
H. W. Maxwell

The purpose in the minds of these early workers in organizing what is now the Portland Cement Association is characteristic of the organization today: first, a desire to progressively advance the science of cement making and the use of concrete, and thus render a sincere service to the users of cement that would give the product a prestige and self-impelling force, and thus enlarge and establish its reputation and its market.

In the light of all that has transpired since the initial gathering of this group of manufacturers, twenty-two years ago, it is interesting to note that the character of the work of the Association was such that before twelve months had passed from its formation, it was working in cooperation and harmony with scientific bodies of the highest standards. Among these may be mentioned the American Society for Testing Materials, the American Society of Civil Engineers, the American Institute of Architects, Iron and Steel Institute, American Railway Engineering Association, and even the United States Government. It was given the rare distinction, seldom bestowed upon a business organization, of participating with leading engineering societies as a member on all committees having to do with the specifications for portland cement and concrete. This was due largely to the character and scientific knowledge of the men representing the Association in the various technical committees and the high character of the scientific papers read before the Association.

At the conclusion of the Association's first year, its membership represented 90 per cent of the total output of portland cement in the United States, then some 22,000,000 barrels. At this time there were 45 concerns in the country, producing over 20,000,000 barrels of cement annually, against a like production by some 96 associated concerns in Germany, which was then the leading European cement producing country.

The minutes of the second meeting of the Eastern Portland Cement Manufacturers practically conclude by recording the appointment of a Sack Committee, consisting of the following:

G. E. Bartol	C. A. Lockard	W. H. Harding
T. H. Dumary	Thos. J. Brady	Robert W. Lesley, ex officio

Preponderance of discussion at this meeting continued to occupy itself with the important subject of sacks, which remained a vexing topic for many years.

At the first annual meeting of the Association, the name "Association of Portland Cement Manufacturers" was adopted. The meeting was held

at the Hotel Bellevue, Philadelphia, December 9, 1902, with twenty members present. The following officers were re-elected:

- Robert W. Lesley, President,
American Cement Company.
- John B. Lober, Vice President,
Vulcanite Portland Cement Company.
- A. F. Gerstell, Secretary,
Alpha Portland Cement Company.
- E. M. Young, Treasurer,
Lehigh Portland Cement Company.

EXECUTIVE COMMITTEE

- H. W. Maxwell,
Atlas Portland Cement Company.
- W. R. Warren,
Virginia Portland Cement Company.
- E. R. Ackerman,
Lawrence Cement Company.
- W. W. Maclay,
Glens Falls Portland Cement Company.
- T. H. Dumary,
Helderberg Cement Company.
- W. H. Harding,
Bonneville Portland Cement Company.
- G. E. Bartol,
Dexter Portland Cement Company.

At this time and for a considerable period afterward the Association had no official headquarters. Among the historical documents of the Association is a letter sent out September 22, 1903, bearing the Association name and the words "Office of the President." It was the office of the American Cement Company, 22 South 15th Street, Philadelphia.

Robert W. Lesley, first President of the Association of Portland Cement Manufacturers, as the permanent organization was named, was born in Philadelphia, 1853. His early education was in France, later at the Langton School, Philadelphia. He entered the University of Pennsylvania in 1867, but left college to engage in business. Many years later, in 1908, the University graduated him with the degree A.M., as of the class of 1871. This was an unusual honor that made him a full alumnus of the University.

Mr. Lesley's early business career began in the office of the Public Ledger, Philadelphia, of which paper he finally became assistant editor. He studied law and was admitted to the bar in 1879. His early association with the pioneers of the cement industry, of which he was one, have been fully given elsewhere. He has long been identified with many scientific and technical societies, and as a mark of honor and the esteem in which he has been held in the industry, he was elected to honorary membership in the Portland Cement Association, 1914.

In the history of the Association, he heads the list of presidents, being the first to serve in that capacity. His term of office covered the year 1903 (from the election at annual meeting December 9, 1902, until election at annual meeting December 8, 1903). The progress of the Association as outlined on the pages which immediately follow is therefore assembled under the heading "Presidency of Robert W. Lesley."

Presidency of Robert W. Lesley

The 1902 annual meeting of the Association of Portland Cement Manufacturers records the appointment of important committees, indicating early realization of profitable Association activities. These included the following:

- Committee on Packages
- Committee on Transportation
- Committee on Finance
- Committee on Uniform Contracts
- Committee on Exports and Increase of Markets
- Committee on New Uses for Cement
- Committee on Uniform Specifications
- Committee on Rules and Legislation

Most of these committees were destined to do important constructive work for the industry, but the committees dealing with specifications and new uses for cement soon proved of special importance.

The package, or sack, question occupied the center of the stage each meeting, but as was true for many years, continued to fail in unanimity of opinion. Even during the second annual meeting, after a lively discussion, it was decided by a vote of nine to eight to postpone the whole subject indefinitely.

Two matters brought before the second annual meeting marked the beginning of expansion along important lines. One was a communication from a New York publishing firm, soliciting financial aid in the publication of articles on cement. The other was a letter from the Central Association of Cement Manufacturers, expressing a desire to cooperate in the work of the new Association.

A list of member companies registered at the second annual meeting, with the individuals representing, follows:

- Alpha Portland Cement Company, G. S. Brown; Mr. Longcope.
- Alsens Portland Cement Company, Mr. Barth; Mr. Babson; R. S. Sinclair.
- American Cement Company, Robert W. Lesley; H. B. Warner.
- Atlas Portland Cement Company, H. W. Maxwell.
- Bonneville Portland Cement Company, W. H. Harding; Mr. Schock.
- Cayuga Lake Cement Company, M. E. Calkins.
- Coplay Cement Manufacturing Company, G. Blumenthal; Mr. Blum.

Dexter Portland Cement Company, G. E. Bartol; Jos. Brobston.
 Empire Portland Cement Company, Charles A. Lockard.
 Helderberg Cement Company, T. H. Dumary.
 Lawrence Cement Company, E. R. Ackerman; I. V. Clark; T. V. Osborne.
 Lehigh Portland Cement Company, E. M. Young.
 Martins Creek Portland Cement Company, J. B. Wight.
 T. Millen & Company, T. Millen.
 Nazareth Portland Cement Company, P. H. Hampson; N. J. Warner.
 Phoenix Cement Company, J. W. Zipperlein.
 Virginia Portland Cement Company, W. R. Warren; D. E. Reinhard; Wm. Burnham; F. W. White.
 Vulcanite Portland Cement Company, John B. Lober; W. D. Lober; George W. Elkins.
 Wayland Portland Cement Company, V. F. Whitmore; Mr. Birch.
 Whitehall Portland Cement Company, Thos. M. Righter; W. C. Kent; J. S. Wentz.

Four quarterly meetings were held during President Lesley's term of office. The first of these was in New York, March 10, 1903. During this meeting there was an interchange of good will and cooperative spirit expressed between the Association of Portland Cement Manufacturers and an organization known as the Central Cement Association. The latter was represented by Charles F. Wade, of the Omega Portland Cement Company, and Secretary of the Central Association, and William Wright, Vice President of the Newaygo Cement Company. At this quarterly meeting the Association entertained as guests representatives of the following eleven western companies:

Omega	Elk Rapids	Hecla
Castalia	Peninsular	Newaygo
Peerless	Alpena	Wolverine
Wabash		Iroquois

represented by Messrs. Wade, Johnson, Patterson, Duffield, Strove, Monaghan, Stroh, Wright, Wood and Davies.

Dr. Wilhelm Michaelis and Dr. J. A. Holmes, representing the St. Louis Exposition, discussed a proposed collective exhibit of cement products at the Exposition, which resulted in bringing the eastern and western manufacturers into closer cooperative spirit than had prevailed up to that time.

But no doubt the matter of greatest importance considered at this meeting was that of uniform specifications, although it might not have been admitted at this early day as important as some uniform method of sack procedure. The Committee on Uniform Specifications, whose personnel was the following:

W. W. Maclay, Chairman	B. S. Dunn
A. F. Gerstell	T. M. Righter
D. Millen	

made a brief report, following which President Lesley submitted the following statement:

The Chair is able to say that there is a movement on foot, in fact walking very fast, toward a uniform specification in a manner which I think will produce what we have all been striving to get, viz., a specification which engineers, architects, the consumer, and the manufacturer can agree upon; and the method of arriving at it is through the American Society for Testing Materials, which has recently appointed a Committee on Cement and Cement Testing, and of that Committee the members of the Committee of the American Society of Civil Engineers who have so far reported on the manipulation of tests of cement are members. Members of the Committee of the War Department who prepared the specifications for the United States Government, are members, and also Chief Engineers of the Pennsylvania, Baltimore & Ohio, Illinois Central, and New York Central Railroads.

Architects and also about ten members of the American Association of Portland Cement Manufacturers, embracing principally those who are on the Committee on Uniform Specifications for Cement, will also take part on the Committee.

The deliberations of that Committee I think will be to this end: The Committee of the American Society of Civil Engineers is limited to the manipulation of tests only—its powers are only those of describing the methods of manipulation. It has cooperated as far as possible on the method of manipulation and has made a report thereon. All are now members of the Committee of Tests of the American Society for Testing Materials, and their work up to the time of their report will be the basis upon which tests will be made, by sending samples of cement to the various mills to be tested. When the results come in an attempt will be made to strike an average and arrive at a specification which will meet the approval of the engineering profession, large consumers of cement, and cement manufacturers, and I believe the result will be a common ground.

At the quarterly meeting held June 15, 1903, at Atlantic City, further consideration was given to the matter of a collective exhibit at the St. Louis Exposition. This represented the first cooperative educational movement of this kind undertaken by American cement manufacturers. The exhibit included a reinforced concrete building, containing an Association laboratory and a display of cement and cement products.

Another important subject brought up for consideration was contained in a communication from the iron and steel interests. This suggested that cement manufacturers cooperate with these interests in preparing specifications directed toward improved methods in reinforced concrete construction. As a result a Committee on Iron and Steel Concrete Construction was appointed, consisting of Messrs. Newberry, Brady, Hagar, Maclay and Wade.

S. B. Newberry suggested the advisability of having scientific papers presented at Association meetings. So it can be seen that the quarterly meeting of June 15, 1903, marked the passing of a more or less passive attitude toward very important matters having to do with scientific and educational work, and showed for the first time that the cement sack, the lowly origin of the call for the first meeting, was unable to hold the center of the stage.

The quarterly meeting of the Association, September 8, 1903, was held at Niagara Falls, New York. There were twenty-eight companies in

attendance and nine absent, showing that at this time the Association had thirty-seven members. Three applications for membership received favorable consideration, thus bringing the membership at this early day to almost half its present membership. Counting the three new members elected at this meeting, the membership represented 90 per cent of the total output of portland cement in the United States.

W. H. Harding, Chairman of the Committee on Exports and Increase of Markets, presented a plan for the formation of a Cement Selling and Warehousing Company. Described in a few words, this provided for an organization to be known as the Export Cement Company or the National Cement Company, which should represent the Association in the sale of cement to be marketed and exported under a general brand instead of the brands of individual manufacturers.

Discussion of the subject resulted in the appointment of a special committee to consider it more fully and report later. The president suggested that the Association obtain actual figures on the monthly production and stocks on hand at the various mills. The Committee on Exports and Increase of Markets was instructed to obtain the data required.

The subject of "Exports and Increase of Markets" finally passed into history, as did many other seemingly important subjects, which later on proved lacking in the importance first supposed.

At the Annual Meeting, December 8, 1903, in New York, forty-two members were represented. The Executive Committee submitted its first annual report. So impressive was its summary of things accomplished that the membership was inspired to further achievement.

The report follows:

First Annual Report of the Association of Portland Cement Manufacturers

New York, December 8, 1903.

The Executive Committee beg to report as follows:

Your Association grew out of a call, signed by twenty-three companies for a meeting at Sherry's, Forty-Fourth Street and Fifth Avenue, New York, on September 11, 1902.

The subject of the call was stated to be as follows:

The undersigned, manufacturers of portland cement, recognizing the fact that the present methods of handling of "sacks" are almost universally unsatisfactory, and believing that the question can be profitably discussed and a satisfactory plan evolved at a meeting of the Eastern mills, hereby pledge themselves to attend such meeting.

Prior to the meeting, the gentlemen in attendance enjoyed a very charming lunch and during the course of the informal speeches the thought of such an Association as we now have was brought forward. The thought was father to the deed, and our Association was formed with twenty members signing the constitution.

Needless to say, that at the first annual meeting of the Association, the question of "bags," out of which the Association grew, was promptly and indefinitely postponed. There was, however, submitted at this time to our Association, which was composed of

representatives of Eastern mills only, a suggestion on behalf of the Central Association of Cement Manufacturers, composed of Western mills exclusively, that the two associations should cooperate. This important suggestion met with the full approval of your Association, and at the quarterly meeting on March 10, 1903, ten companies, members of the Central Cement Association, were present, and all became members of our Association, thus making the Association of Portland Cement Manufacturers no longer local, but a National Association. The membership has now grown from twenty to forty-six, representing manufacturers from the Atlantic to the Pacific Coast. The estimated output of portland cement which is now represented in our body is from 90 per cent to 95 per cent of the total output of the United States.

During the year there were brought forward many questions involving freight rates and also other transportation questions. The most important of these and the settlement of which was brought about by cooperation between our Association and the railroads was a uniform method regarding the return of empty bags. This action resulted in the issue of uniform circulars by all the members of our Association to their respective customers, and similar notices by all the railroads to their freight agents, resulting in a uniform method for the return of bags and the payment of freight thereon.

In the fall there was also a reduction of freight to Chicago and Western points not taking the 60 per cent rates; another result of the work of our Transportation Committee.

Under similar lines of cooperation a committee was appointed by your Association to confer with representative manufacturers, members of the Iron and Steel Institute, in the matter of testing and standards for concrete steel construction. This suggestion, which had root in our Association, has extended from the two associations originally contemplated to the American Society for Testing Materials, which has appointed a committee to act in unison with those already referred to. The effect of this will be that by standard methods in this important form of construction the possible danger to the cement industry by improper and careless construction of concrete steel bridges, buildings, etc., will be entirely obviated.

The importance of a standard specification for cement has certainly been recognized by all of those connected with cement, either as engineers, consumers or manufacturers. Certainly, no class recognizes it more fully than the members of our Association. To do away with the many hundreds of varying specifications which come to the mills during the course of the year, and to substitute for them a single specification well thought out, well considered, and well adjusted, would be of great value.

Following the line of cooperation already referred to as part of the business of this Association, your Cement Committee has been represented upon a joint committee of the American Society for Testing Materials, and a suggested specification has now been sent for final examination and approval to all its members, with the object of having replies by February 1, 1904, at which time a meeting will be held for the final adoption of the specification.

It is needless to say that a standard specification, which has grown from the intelligent work of the American Society of Civil Engineers' Committee, coupled with the thought of the United States army engineers, the American Railway Engineering and Maintenance of Way Association, the American Society for Testing Materials, and your own Association, and practically determined in the laboratories to which the samples were sent, will, when adopted, command the regard and respect of all engineers, consumers, and producers of cement.

Further in the line of cooperation with sister societies may also be mentioned the meeting held in New York on December 1, 1903, between your Committee on Uniform Contracts and a committee appointed by the National Builders' Supply Association to

confer with us on the subject named. This was the first meeting between the manufacturers of, and the dealers in, cement, and it may be stated that the best of feeling and cooperation marked the meeting, and that it was thought highly advisable by both parties that many similar meetings should be held during the course of every business year, and the National Builders' Supply Association have emphasized their views on the subject by extending our Association an invitation to join the annual meeting of the National Builders' Supply Association, to be held at Buffalo, N. Y., on February 3, 1904.

At the meeting of our Association on March 10, 1903, representatives of the St. Louis World's Fair were present, and outlined plans for a general exhibit of the cement manufacturers. A committee was appointed, with Mr. Robinson of St. Louis as Chairman, and the report of that committee is before you. Hearty cooperation on behalf of all the cement manufacturers has been shown, and it is hoped that a building will be erected at the World's Fair, which will be a monument to the cement industry, not only for the year 1904, but for many years to come.

The question of statistics of the cement industry has given your Executive Committee considerable thought. During the year there have been sent to all members reports of figures of the United States Bureau of Statistics, showing the imports and exports of cement, and from these it has been possible to gather some idea of the conditions of our foreign trade, and of the effect of foreign importations upon our domestic industry. Following this line of thought it has been proposed that this Association should be made the center of the cement statistics of the United States, and that upon the plans used by the Iron and Steel Institute there shall be received by our Assistant Secretary monthly or quarterly reports of the stocks of cement on hand and of the number of mills that are in operation, from time to time, as bearing upon the general cement situation in the country. Your Executive Committee strongly urges the carrying into effect of this plan of gathering correct and valuable statistics.

The manufacture of portland cement by the United States Government, on the site of the Tonto Dam, in Arizona, was brought before your Executive Committee by representatives of mills on the Pacific Coast, and in connection with these gentlemen who have now become members of our Association, an effective argument was addressed to the Secretary of the Interior, after a hearing of several hours, in which the matter was fully gone over, a decision was rendered giving the victory to the cement men, the Government deciding not to make cement on the site of the dam, but to advertise for bids for cement under either of the two following methods, viz.:

First—Cement manufactured elsewhere and shipped to Phoenix or Globe by rail, and then hauled to the dam site.

Second—The Government to furnish a 250-barrel-per-day mill at the site with power to operate it, and the contractor to manufacture it there.

In the relation sustained by our body to the Government, several communications have been addressed to the Secretary of War in the matter of changes by Government engineers of the requirements of the United States Army specifications, and communications have also been had with the Census Bureau, by which modified forms of census reports have been allowed, and also communications with the State Department, securing for us Consular reports on cement from all parts of the world.

Better methods of warehousing cements have been before us at some of our meetings.

Questions have also been considered in relation to the sending of American representatives to foreign countries for the purpose of developing the export trade of this country in our product.

The year's work has largely been of a constructive character, in view of the fact that the Association was a new one and had by degrees to find its proper field. With the

incoming of a new year and the larger introduction of new blood into the organization, the Executive Committee expresses the hope that much good work and many new lines of thought may be found for our busy hands to do.

Approval by the Association of this report stamped it as an official estimate of Association work as interpreted by its Executive Committee. That the importance and value of this work were not exaggerated was shown by the fact that outside interests were watching the progress of the Association and had arrived at conclusions entirely favorable to it.

On December 19, 1903, the Engineering Record, New York, published the following editorial:

The Association of Portland Cement Manufacturers

The value of cooperation between establishments in the same industry is well shown in the history of the first year's work of the Association of Portland Cement Manufacturers, which held its second annual meeting in New York last week. This organization started as a local body, convened on September 11, 1902, to discuss the matter of handling empty sacks. The call for this meeting was signed by twenty-three Eastern companies, but very early in the session the question of sacks disappeared from sight for the time being before the more important subject of a permanent society. It was decided to invite the Central Association of Cement Manufacturers to join the Eastern companies, and in March of this year ten of them were admitted and the present organization thus started on its way as a national body. Today there are forty-six companies on its roll, representing all sections of the country where the industry is established and from ninety to ninety-five per cent of the total output. While the organization is thus a young one, it is thoroughly representative of American portland cement manufacturers, and its work is of importance to all who make and use cement.

In the report of the Executive Committee presented at last week's meeting by the retiring president, Robert W. Lesley, some interesting indications are given of the important influence such an organization can exert in the improvement of engineering practice. The subject of concrete-steel construction may be taken as an example. It was recognized some time ago that the cement industry was open to a certain measure of injury by the possible failure of reinforced concrete structures. The interest in this system of building is so great that it is probable a certain number of serious accidents will result through the attempt to erect work on improper plans or by careless methods. To avoid such a danger so far as possible, the Association applied to representative members of the Iron and Steel Association for assistance in formulating and making public sound ideas on this subject. These two organizations were able to offer exceptional facilities for experiments, but in order to give such work the professional scientific standing it needs to carry weight, the cooperation of the technical organizations was sought. The American Society of Civil Engineers will take up the matter of such cooperation next month, while the American Society for Testing Materials has already appointed a committee to act with the representatives of the other societies.

The Association's action in relation to testing cement is also something for which the engineering profession has reason to be grateful. The number of specifications for cement that were in use a few years ago was legion: while the manufacturer could supply material satisfying all of them with few exceptions, the absence of uniformity caused a needless extra expense to the purchasers and unnecessary addition to the details of manufacture. Various attempts had been made to check the writing of a new form of specification for each concrete work, but little was accomplished until this Association

took the subject in hand. The American Society of Civil Engineers had a committee which was doing good work on the restricted subject of the manipulation of tests of cement. The Association was able to add greatly to the value of the committee's work by placing at its disposal the resources of numerous works, laboratories, and ample quantities of cement of any grade desired. Meanwhile the American Society for Testing Materials appointed a cement committee to take up the whole subject of the tests of cement. As the work of the Civil Engineers' committee covered a part of this field, the committee was asked to join the new and great committee as a body, and this was done. The Association of Portland Cement Manufacturers was also able to secure on this large committee representatives of the American Railway Engineering & Maintenance of Way Association and of the engineering departments of the New York Central, Baltimore & Ohio, Illinois Central, and Pennsylvania railroads, and the American Institute of Architects has been invited to take part also. As a result of all this work a scheme for a standard specification for cement has been drawn up and submitted to members of the committee for their consideration. It is needless to say that a specification which receives the endorsement of the representatives of all the interests now working harmoniously in this way will carry sufficient weight to become the standard for some years to come. It may not cover special requirements but for such requirements the purchaser must expect to pay a greater price than for the standard grades.

In a business way the Association has also accomplished a great deal of good. The handling of empty bags by the railroads has been settled on a basis which is satisfactory to all concerned, and freight rates have been reduced to many points. The relations between the manufacturers and supply men have been made more harmonious, and arrangements have been perfected for an interesting exhibit at the Louisiana Purchase Exposition. A still more important action was recently taken with regard to the manufacture of portland cement by the United States Government at the site of the Tonto River dam in Arizona. On account of the principle involved in this proposal, the Association made representations to the Secretary of the Interior which resulted in a decision by the government not to make cement at the site of the dam but to advertise for bids for cement under either of the two following methods: First, cement made elsewhere and shipped to Phoenix or Globe by rail and then hauled to the dam site. Second, the Government to furnish a 250-barrel-per-day mill at the site with power to operate it, and the contractor to manufacture the cement there. Another important work which is still under consideration relates to the compilation of statistics of the cement industry, along the same lines as the statistical work of the Iron and Steel Association. The idea is to have monthly or quarterly reports sent to the Association headquarters of the stocks of cement on hand and the number of mills in operation. These figures are to be tabulated according to districts and not mills, so that the trade will know the general condition of stocks and mills and thus be in a position to handle its work to the best advantage.

It is believed that this outline of the work of the Association during the first year of its existence is a good indication of the importance of its field. The old idea that the manufacturer of materials of construction is the enemy of the engineer falls to the ground in the face of such a record. In its one year of usefulness this manufacturers' organization has done more to advance sound masonry construction than all other societies together. It has brought purchaser and manufacturer together, furnished facilities for elaborate investigations, and shown itself ready to cooperate in every way to further the best interests of sound masonry construction. A large part of the success of this work has been due to the energy of Mr. Robert W. Lesley, the Association's first president, whose tact in harmonizing all interests, both business and professional, has been of the greatest value in the inauguration of its work.

If anything tended to make the second Annual Meeting of the Association outdistance previous ones, it was evidence of more sincere co-operation and mutual confidence expressed in every action of the membership.

The matter of contributing information on monthly production and stocks on hand at the various mills formed a subject of discussion. John B. Lober urged prompt action and the discussion was terminated by a unanimous vote on a proposition to have monthly production and stocks statistics information on file.

In retiring from the office of President, Mr. Lesley said:

There is nothing more gratifying than to be in this room and hear the expressions of absolute confidence from member to member—from all of those who are attending the deliberations of this Association. This is the first big ray of daylight that seems to have come into our body. It seems that we are an Association and not a set of members.

The Committee on New Uses of Cement embodied in its report the greater portion of a lecture given before the Philadelphia Engineers' Club by President Lesley, in which emphasis was placed on the advantages of using concrete in many fields.

The Committee on Uniform Contracts presented suggested forms to be used between manufacturers and dealers, and manufacturers and contractors. Conferences on this subject had been held by the Committee with representatives of the National Dealers' Association, which attracted the attention of that important body to the work of the Association, resulting in cooperation along several lines.

Mr. Lesley declined a renomination as President.

The Report of the Nominating Committee presented the following candidates, who were elected:

John B. Lober, President

E. M. Young, Secretary

A. F. Gerstell, Vice President

E. R. Ackerman, Treasurer

EXECUTIVE COMMITTEE

H. W. Maxwell

W. R. Warren

Edward M. Hagar

W. H. Harding

G. E. Bartol

S. B. Newberry

Robert W. Lesley

On taking the chair as second President of the Association, Mr. Lober called attention to the fact that the organization represented one of the most important industries in the country, which he predicted would rank second to the great iron and steel industry. He emphasized especially the importance of cooperation with consumers of cement in the interest of intelligent and economic use as distinguished from a purely selfish policy. He prophesied that such a plan, once inaugurated and scrupulously followed, would assure the success of the Association.

From that day to this, no manufacturer of portland cement has taken a more active and unselfish interest in the general success of the industry

than has Mr. Lober. He was among the first to see the advantages of cooperation on the part of manufacturers in work such as the Association had mapped out for itself. He was always the most active participant in the proceedings of the many meetings to follow and foresaw that the Association was to become not only the official representative of a great industry, national in its activities, but also would attain a responsibility to the users of cement which could not be disregarded.

President Lesley's term of office witnessed the building of the foundation of the Association. It was to the superstructure, Mr. Lober said, that members must henceforth devote themselves. He emphasized the importance of standardization in procedure along many lines, including methods of testing cement and establishing specifications for the product. He stressed the importance of promoting new uses for cement and urged that papers upon subjects of interest to the cement manufacturer and user be included in subsequent meeting programs. With far-seeing vision he urged elimination of all jealousies, personal animosities, and antagonism, in order that members might work together for a common good and to the advantage of the industry as a whole.

At this meeting the Constitution of the Association was amended in accordance with the following proposal by Mr. Lober:

The Association is formed for the purpose of discussing various questions of interest to the industry arising from time to time, and to exchange views as to the best method of manufacturing, extending, developing, and conducting the business, and to do all things incidental and conducive to the attainment of the above objects.

Presidency of John B. Lober 1904-1909

John B. Lober was born in New Jersey in 1848.

From 1877 to 1883 he was a member of the firm of Warren, Lober & Co., distillers of coal tar and manufacturers of coal tar products.

From 1883 to 1901, Mr. Lober was Vice President of the Vulcanite Paving Company.

In 1894, the Vulcanite Portland Cement Company was incorporated, Mr. Lober being one of the original incorporators. He was elected Vice President and General Manager of this company in 1898, and President in 1903.

Mr. Lober served as President of the Portland Cement Association throughout two periods—1904 to 1909 inclusive, and 1913 to 1915 inclusive. He was also Treasurer of the Portland Cement Association during the years 1911 and 1913.

This chapter deals with Mr. Lober's first term of office as President of the Association of Portland Cement Manufacturers.

The first quarterly meeting of 1904 was held March 8 and 9 at the Hotel Walton, Philadelphia. This marked the first occasion of a two days' session.

Before the general session of the Association convened, the Executive Committee had been considering the subject of the Panama Canal. Attention was called to the fact that there was no provision for the use of American portland cement on this work, but that the Canal would be built under the direction of the War Department, which department in its specifications required the use of American portland cement. Further than this was the fact that the work on the Canal was to be in a neutral zone; and materials of American manufacture would enter free of duty, which would give American cement an advantage of practically 30 cents a barrel over the foreign made product.

When the Committee on Statistics presented its report, it was found that a number of companies had not reported figures on production and stocks. On this subject President Lober made the following statement:

If there is one business in which members and management have been entirely at sea, it is the cement business, and anything that will bring us down to a plane of actual facts is something we should all follow.

The matter of the testing laboratory at the St. Louis Exposition was referred to the Executive Committee with the recommendation that Richard L. Humphrey, Consulting Engineer, be placed in charge.

The very important decision was reached to have a thorough investigation made as to the behavior of concrete in the Baltimore fire. As a result, highly important facts were secured which were used to great advantage in later years.

This meeting marked also the first discussion of a technical subject, the burning of cement, which was presented at a dinner given by Robert W. Lesley. The subject was discussed by Professor Joseph W. Richards, who explained his important investigations with a 60-foot rotary kiln at the plant of the Dexter Portland Cement Company, Nazareth, Pennsylvania.

On the second day's sessions, the first formal presentation of technical papers was made. One of these papers related to the grinding of cement and was presented by George W. Frazer, New York. The other was by S. B. Newberry and related to work of the German Portland Cement Manufacturers' Association. This paper marked the initial step of the American Association in keeping in touch with foreign methods.

The second quarterly meeting of 1904 was held June 14 and 15 at Atlantic City. This meeting recorded further progress along technical lines.

The Committee on Uniform Specifications reported work in conjunction with a committee composed of officers of the United States

Army, the American Institute of Architects, American Society of Civil Engineers, Railway Engineering and Maintenance of Way Association, and the American Society for Testing Materials. A specification prepared by the Committee represented all of these bodies and had been sent out to members of the Committee, who had approved it by a very large majority, with comment that favorable action on the part of the American Society for Testing Materials was anticipated. The President urged that the Association come to a definite conclusion as to the requirements of the specification from the Association's point of view. It was finally decided to approve of the specification as prepared by the Committee of the American Society for Testing Materials. This marked a very important step at this early period.

That foreign cement manufacturers were watching the progress of the Association is best indicated by stating that at this meeting an application for membership was received from Dyckerhoff & Sons, the great German cement manufacturers, but under the Constitution and By-laws of the Association, this application was necessarily rejected.

Steps were taken to have responsibility for the activities of the Association made more binding upon its members. The matter came up when the appointment of a Committee to revise the Constitution and By-laws was under consideration. Discussion resulted in convincing members that they should be more thoroughly bound by the acts of the Association than had been theretofore the case.

The first step to obtain full information on foreign uses of cement was taken at this time, following a resolution offered by W. R. Warren directing the Executive Committee to formulate a plan for the purpose, and to report on the advisability of sending a competent engineer abroad to procure data on cement construction.

The quarterly meeting of September 13, 1904, was held at St. Louis while the World's Fair was in progress.

President Lober called attention to the fact that the Association had for the first time in its history assembled in a building of its own (the concrete exhibition building erected by the Association on the Fair Grounds), its own laboratory and scientific exhibit, and other visible evidence demonstrating the utility of concrete. The Association structure was substantial, attractive, fire-resistive and designed as a permanent building. The fact that the exhibition at the Fair was so successful, indicated that the Association had become liberal and broad minded to a degree quite in contrast with three years previous, when, as Mr. Lober said, it would have been impossible to have obtained funds for any such purposes.

Among various committee reports presented at this meeting was that of the Committee on Iron and Steel Concrete, which announced that

it had formed a joint committee with a committee on the same subject appointed by the American Society of Civil Engineers and the Railway Engineering and Maintenance of Way Association. As the result of this joint committee there had been appointed sub-committees on Plan and Scope, thus providing for extensive experiments on construction of columns, beams, etc., involving several years' study before a final and definite summary would be presented.

The Annual Meeting of 1904 was held December 13 and 14 at the Hotel Astor, New York.

At the suggestion of Mr. Carrere of the Penn Allen Portland Cement Company, the Constitution was amended so as to include the word "American" in the title of the Association. Thereupon the name became the Association of American Portland Cement Manufacturers, which continued up to 1916.

At this Annual Meeting increased dues of membership were approved—an important step in the direction of greater activities.

How the Association has expanded in this respect is an interesting item in its history. The first Treasurer's report referred to in the early minutes of the Association, was presented at the Annual Meeting, December 9, 1902. E. M. Young, Treasurer, stated that he had received subscriptions from 18 members, amounting to \$1800, with six companies to be heard from. At the Second Annual Meeting the Treasurer reported that the dues amounted to \$2,500; in 1915 the financial resources amounted to \$210,000; in 1916 the dues received amounted to approximately \$600,000; by 1920 the annual appropriation for promotional and educational work was in excess of \$1,500,000, which by 1923 had increased approximately to \$2,500,000.

After increasing the dues at the 1904 meeting, the Association gave favorable consideration to a proposal that a paid Secretary be appointed. This marked another advance calculated to increase its efficiency as a working organization.

In the report of the Executive Committee presented at this meeting was a statement that the membership then represented 90 per cent of the productive capacity of the portland cement mills of the United States.

The annual election resulted in the following:

John B. Lober, President

A. F. Gerstell, Vice President

E. R. Ackerman, Treasurer

No Secretary being elected in view of the purpose to appoint a paid secretary.

EXECUTIVE COMMITTEE

The Executive Committee was increased as to number, the following being elected:

Charles P. Wade	W. W. Maelay	S. B. Newberry
Edward M. Hagar	S. H. Bassett	Robert W. Lesley
T. H. Dumary	E. M. Young	W. R. Warren
T. J. Brady	W. H. Harding	D. McCool

Papers read at this meeting and subsequently published, covered cement testing, reinforced concrete, and the constitution of portland cement. It had already become established practice of the Association to include with strictly technical papers an occasional contribution from manufacturers of cement machinery, in order that the membership might keep fully informed as to progress along mechanical lines.

In the history of the Association up to and including this 1904 Annual Meeting, there has been incorporated considerable detail which may be considered uninteresting reading by those who were not participants in these early proceedings, but only the high spots have been touched. Although enough has been written so far, and the records presented show that suggestions to make radical departures into new fields were favorably received in the main, there was nevertheless underneath the old spirit born of doubt calculated to arouse suspicion, if not distrust. The elimination of this was the first great achievement. Then came recognition of the Association's responsibility to the users of cement and an awakening to the fact that every advance along scientific and economic lines calculated to promote the best interests of the consumer must redound to the ultimate advantage of the maker. To reach this point required courage, sound judgment, and honest purpose; and associated with the history and ultimate achievements of the Association will always appear the names of those who fought in the struggles of the first two years.

Among matters taken up in 1905 directed towards increased use of cement was application of the product to building construction. Concrete block had begun to attract attention and made so favorable an impression at the outset that some enthusiasts believed they would largely supplant common brick. Not only did the Association seek to promote the manufacture of concrete block, but it adopted the broad policy of attempting to have manufacturers turn out a first-class product. This was done in part by devising specifications for manufacture. In cooperation with Cement Age, prizes were offered for papers on the manufacture and use of concrete block. Competing interests were so concerned over the possible outcome of Association promotion in this field that many bricklayers refused to lay ordinary brick on concrete foundations.

The Association also made an appropriation to carry on investigations of the fire-resisting properties of concrete. It investigated the pos-

sibilities of establishing a laboratory. Appropriations were made to assist the Committee on Concrete and Reinforced Concrete. And for the first time the Association acquired actual headquarters—a small office in the Land Title Building, Philadelphia.

W. H. Harding, Chairman of the Committee on Standard Specifications, encountered difficulties in getting users of cement to agree upon standard specifications. The Navy Department was out of harmony with the idea and members of the Association were urged to decline bidding on any specifications other than the standard ones adopted by the American Society for Testing Materials.

The Association's Committee on Technical Research came into existence in 1905. The membership of this Committee was as follows:

S. B. Newberry, Chairman	Jos. Brobston	C. A. Matcham
Robert W. Lesley	G. F. Bayle	H. A. Schaffer
A. F. Gerstell	Edward M. Hagar	A. Lundteigen
W. H. Harding	E. R. Ackerman	W. R. Warren
D. D. Drummond		John B. Lober

In order to better establish the reputation and quality of portland cement, members agreed to manufacture only a true portland cement which was defined as follows:

The undersigned members of the Association of American Portland Cement Manufacturers agree and hereby bind themselves to put on the market, under the name of PORTLAND CEMENT, no product but one made by burning to the point of sintering, an intimate mixture consisting essentially of lime or carbonate of lime and silicious material of the general chemical composition of clay, and grinding the resultant clinker to fine powder, without any addition made subsequent to the burning other than that of material for the purpose of regulating the setting, the amount of which shall not exceed three per cent.

The annual election resulted in the following:

John B. Lober, President
Chas. F. Wade, Vice President
E. R. Ackerman, Treasurer

EXECUTIVE COMMITTEE

Robert W. Lesley	W. R. Warren	T. H. Dumary
A. F. Gerstell	W. J. Prentice	Conrad Miller
E. M. Young	S. B. Newberry	W. H. Harding
Edward M. Hagar	T. J. Brady	Duane Millen

The papers presented during 1905 described work of the St. Louis Laboratory, tests of cement at Watertown Arsenal, fuel consumption in cement burning, the grinding of portland cement, reinforced concrete from a commercial standpoint, air separation in portland cement grinding, hollow concrete block construction, methods of testing cement, artistic possibilities of concrete, and an abstract of report of the German Cement Manufacturers' Association.

In 1906, a resolution was adopted by Congress providing that purchase of material and equipment for use in the construction of the Panama Canal should be restricted to articles of domestic production and manufacture when not unreasonable in cost. This action may be considered as a direct result following a hearing granted to the Association Panama Canal Committee, whose members were the following:

Robert W. Lesley
H. C. Trexler
S. B. Newberry

J. Rogers Maxwell
A. F. Gerstell

E. R. Ackerman
Edward M. Hagar

Further impetus was given to the establishment of an Association laboratory.

It was announced that approximately \$5,000 had been raised to facilitate the work of the Committee on Iron and Steel Concrete, and an appropriation of \$2,000 was made to provide for a prize competition among architects for concrete house plans, these to include both monolithic and block construction.

During the year, President Lober and Robert W. Lesley were appointed by President Theodore Roosevelt, members of the United States Advisory Board on Fuels and Structural Materials, Mr. Lober as representative of the Association of American Portland Cement Manufacturers and Mr. Lesley as representative of the American Society for Testing Materials, of which he was then Vice President.

The adaptability of concrete for fortifications and batteries was called to the attention of the Association by a Government report on its use for such purposes during the Russo-Japanese War.

Another contribution, in the form of facts relating to the utility and economy of concrete was a lecture by Richard L. Humphrey, illustrating the remarkable resistance of concrete to earthquake shock and fire in San Francisco, as was true in the case of the Baltimore fire. These facts served a most useful purpose in later years in the promotion of reinforced concrete.

The scientific side of cement and concrete was advanced by a number of papers. The importance of using proper sand in concrete was discussed by Sanford E. Thompson. William L. Price, of the architectural firm which designed the first reinforced concrete hotel at Atlantic City, spoke upon and emphasized the artistic possibilities of the material in that particular construction field. The construction of concrete piles, cost reduction in concrete construction, and a comparison of ancient and modern mortars, were among other subjects presented for the enlightenment of members.

The annual election resulted as follows:

John B. Lober, President
C. F. Wade, Vice President
E. R. Ackerman, Treasurer

EXECUTIVE COMMITTEE

Robert W. Lesley	Conrad Miller	E. M. Young
T. H. Dumary	Duane Millen	W. R. Warren
Edward M. Hagar	N. D. Fraser	S. B. Newberry
A. F. Gerstell	W. H. Harding	G. E. Nicholson

The year 1907 was marked by a number of happenings or accomplishments contributing important progress to the Association. A committee representing the National Board of Fire Underwriters and the National Fire Protective Association, both of which organizations were in session that year, presented a report considered by cement manufacturers as unfair to concrete. The Association delegated to Robert W. Lesley the responsibility of refuting the general tenor of this report. Mr. Lesley was also appointed chairman of a committee to represent the Association before the New York Building Code Commission. Those who served with him were W. N. Beach and A. W. Paige.

The refusal of financial institutions to lend money on concrete block houses was another matter taken up by the Association.

During 1907 the Association issued its first periodical, "The Concrete Review." This met with a favorable reception in engineering circles, its contributors being authorities on all the subjects presented.

A new architectural competition providing for more costly concrete dwellings than the one presented in the former competition was planned.

A gratifying trend of the times was a more general acceptance of specifications. The cause of concrete failures was taken up, with the result that the Association produced convincing evidence that careless workmanship and poor design were chiefly responsible for such failures as had occurred.

Although it was a number of years later before concrete obtained recognition as a paving material, it was in 1907 that the first important papers dealing with the use of concrete in street and road work were presented to the Association. One road paper described the Hassam type of pavement, the forerunner of the modern concrete road.

Initial steps had been taken the preceding year to secure a paid Secretary to direct the growing affairs of the Association. This resulted in the election by the Executive Committee of Percy H. Wilson.

At the annual meeting the following were elected:

John B. Lober, President
Edward M. Hagar, Vice President
E. R. Ackerman, Treasurer

EXECUTIVE COMMITTEE

N. D. Fraser	W. H. Harding	L. M. Wing
G. E. Nicholson	E. M. Young	W. R. Warren
T. H. Dumary	Robert W. Lesley	J. W. Kittrell
A. F. Gerstell	Conrad Miller	W. S. Mallory

In 1908 the first steps were taken to familiarize farmers with the possibilities of concrete construction. Practical bulletins covering a number of subjects were printed and distributed in large editions. Farm papers and newspapers were supplied with reading matter and illustrations. The house competition plans were so popular that an additional 10,000 copies were soon exhausted.

The annual election resulted as follows:

John B. Lober, President
 Edward M. Hagar, Vice President
 E. R. Ackerman, Treasurer

EXECUTIVE COMMITTEE

John B. Lober	T. H. Dumary	L. M. Wing
Edward M. Hagar	A. F. Gerstell	J. W. Kittrell
E. R. Ackerman	W. H. Harding	George S. Bartlett
N. D. Fraser	Robert W. Lesley	E. M. Young
G. E. Nicholson	Conrad Miller	W. S. Mallory

Activities of the various Association committees were indicated by the reports which these committees presented in 1909. Among these were reports of the Committee on Concrete and Reinforced Concrete and the Committee in charge of the New York Building Code data.

The work of the Committee on Concrete and Reinforced Concrete embodied the first rules looking toward better concrete. Much also had been accomplished in the way of design and research pertaining to working stresses. Included were important data on the fire-resistive properties of concrete.

It was due largely to the efforts of the Association's New York Building Code Committee that Mayor McClellan of that city vetoed the first code presented.

The Association announced its ability to furnish standard Ottawa sand for testing purposes, this product being backed by the authority of engineering and technical associations.

The United States Department of Agriculture cooperated with the Association in a number of ways. The Department had become interested in farm construction and concrete roads. Through its members the Association donated cement for experimental roads, several important projects being launched in 1909. A great deal of educational matter on concrete was sent to agricultural colleges and experiment stations. Inquiries for bulletins from various sources to the number of 17,000 had been received.

The Association began the collection of a representative file of photographs illustrating the varied uses of concrete.

President Lober, owing to ill health, declined renomination and the election at the annual meeting resulted in the following:

W. S. Mallory, President
Edward M. Hagar, Vice President
E. R. Ackerman, Treasurer

EXECUTIVE COMMITTEE

G. E. Nicholson	E. M. Young	C. H. Zehnder
T. H. Dumary	Robert W. Lesley	Bethune Duffield
A. F. Gerstell	Conrad Miller	Robert W. Kelley
W. H. Harding	George S. Bartlett	

Presidency of W. S. Mallory 1910

W. S. Mallory was born in New Haven, Connecticut, 1861.

His early education was in the Baltimore schools.

He entered the iron and steel business in 1881 in Chicago with Carmichael & Emmons, later buying out the concern and continuing it under the name of W. S. Mallory & Company until 1891.

In 1888 Mr. Mallory became associated with Thomas A. Edison, interesting himself in the concentration of low grade iron ore. In 1891, Mr. Mallory sold out his interest in the firm of W. S. Mallory & Company and spent the next eight years studying iron ore concentration.

In 1899, with Thomas A. Edison, Mr. Mallory assisted in forming the Edison Portland Cement Company. He was Vice President of this company until 1908, when he was elected President, and continued in that capacity until 1918, when he retired from active business.

Mr. Mallory was elected Honorary Member, Portland Cement Association, December 1919.

Only two meetings were held in 1910. The Semi-annual Meeting took place in Chicago in June and the Annual Meeting in New York in December.

The general educational-publicity work of the Association at this time was attracting wide attention. Literature distribution and co-operation with various other organizations were responsible. The Association had accumulated a considerable library on the uses of cement and concrete, which was believed to be the best in that particular line in the country. It had some 2500 photographs and some 1200 lantern slides, this material being placed at the disposal of lecturers, and in that way receiving liberal circulation.

Expression was made at one of the meetings during 1910 that the consumption of cement by small users had increased annual production

some 10,000,000 or 15,000,000 barrels, this being accredited solely to the publicity work of the Association. Because of an established policy never to criticise or condemn competitive materials, nor to advocate cement for purposes for which it was not suited, the Association had won a large measure of public confidence.

It was during President Mallory's term that the dues of members were fixed on the production basis and increased to facilitate further publicity work.

The Constitution was amended at the Annual Meeting to provide for admitting foreign manufacturers to membership.

The annual election resulted as follows:

Edward M. Hagar, President

W. S. Mallory, Vice President

John B. Lober, Treasurer

EXECUTIVE COMMITTEE

E. R. Ackerman

George S. Bartlett

A. H. Craney, Jr.

Bethune Duffield

T. H. Dumary

Robert W. Kelley

Robert W. Lesley

Conrad Miller

John R. Morron

S. B. Newberry

G. E. Nicholson

C. H. Zehnder

Presidency of Edward M. Hagar 1911, 1912

Edward M. Hagar was born at Salem, Massachusetts, 1873.

He was graduated from Massachusetts Institute of Technology in 1893, and the next year completed a post-graduate course at Cornell.

Mr. Hagar's business career began through organizing the firm of Edward M. Hagar & Company, Chicago, representing various machinery manufacturers. In 1901, he was made Manager, Cement Department, Illinois Steel Company. On incorporation of the Cement Department as the Universal Portland Cement Company in 1906, Mr. Hagar became President of the new organization.

In January, 1915, he resigned the Presidency of the Universal Portland Cement Company and for the three years following was associated with a number of enterprises, among them the Wright-Martin Aircraft Corporation as President, then as President of the American International Steel Corporation.

Mr. Hagar died after a short illness from pneumonia, January 18, 1918.

On assuming the presidency of the Association, President Hagar ventured the prediction that 1911 would be one of the best the Association had witnessed for many years.

Technical progress during 1911 included Association cooperation in the proposed revision of the United States Government specifications for cement. The Association's Committee on Technical Research and the

Association Laboratory worked in cooperation with the Institute of Industrial Research in Washington. Important work was also accomplished in cooperation with the United States Bureau of Standards.

Further progress was recorded in the matter of standard cost accounting, which had come to be regarded as of great importance.

More favorable insurance rates on concrete buildings were obtained.

Accident prevention work in member plants by the Association was also first attempted in 1911.

Distribution of Association literature was largely increased and work was begun on the preparation of a book covering reinforced concrete factories and warehouses. The stock of photographs and slides was enlarged and a set of slides presented to each of the agricultural colleges in the country. Preparation of data calculated to assist the United States Department of Agriculture was continued. Through the distribution of printed matter, inquiries coming to the Association had increased to such an extent as to require a bureau to give them prompt and complete attention.

The American Society of Mechanical Engineers established a Cement Section, which resulted in close contact between the Association and that organization.

Through investigation of all complaints concerning the behavior of concrete under various conditions, the Association found that many of the complaints were without good ground, and proper educational work was done in this field.

That the efforts of the Association to increase the use of cement were effective, was shown by comparing growth in the use of cement with the situation in other industries, where the demand for materials had fallen off. This was attributed entirely to the increased use of cement for small or individual undertakings, as contrasted with large engineering projects. To supplement this work, the Association undertook the preparation of bulletins on ornamental and decorative concrete, drain tile and sewer pipe, bridges and culverts, small farm buildings, grain elevators, houses, cottages and bungalows. Special attention was given to concrete road construction.

The annual election resulted in the following:

Edward M. Hagar, President

W. S. Mallory, Vice President

John B. Lober, Treasurer

EXECUTIVE COMMITTEE

Edward M. Hagar

A. H. Craney, Jr.

Bethune Duffield

T. H. Dumary

Robert W. Kelley

W. H. Harding

Robert W. Lesley

John B. Lober

W. S. Mallory

Conrad Miller

John R. Morron

S. B. Newberry

Whitney Newton

G. E. Nicholson

C. H. Zehnder

The minutes of the Spring meeting of the Association, which was held in Chicago in May, 1912, consisted of 126 printed pages. There was also issued a pamphlet of 45 pages, containing papers and addresses presented before the Association. These publications serve as an index of the organization's progress and growth.

Cost accounting and accident prevention work continued to occupy increasing attention on the part of the membership. An extended report of the work conducted by the Institute of Industrial Research was filed. This included data concerning the behavior of cement and concrete under stated conditions. The effect upon concrete of oils, various industrial solutions, and materials used in manufacture and the industrial arts, had been the subject of experiment, showing that concrete was suited to many industrial purposes to which previous conclusions, based largely upon assumption, had debarred its use. The United States Bureau of Standards inaugurated important experiments, among them tests of reinforced concrete beams and slabs.

Various engineering and technical organizations, the United States Government, and the Association grew nearer to accord as regards specifications and testing of cement than had been the case previously.

General publicity work was continued with great success. Many lectures were given by members of the Association engineering staff—a new feature of educational work. A single bulletin prepared from data supplied by the Association was issued by the United States Department of Agriculture and reached a distribution of nearly half a million copies. A corresponding number of bulletins on concrete in the country was distributed by various Association members. As the result of distribution of the booklet covering reinforced concrete factories and warehouses, one member of the Association reported that at least five important buildings in his city had been built of concrete solely because the owners had seen this book.

Interest in concrete roads continued to increase and during the year various persons presented important papers on the subject before the Association. One of these was by Logan Waller Page, of the United States Bureau of Public Roads.

In another respect the year was remarkable. It marked the tenth anniversary of the founding of the Association. During the decade, production of portland cement had increased from some 17,000,000 barrels to more than 80,000,000 barrels, an increase of 365 per cent. The Association began with twenty members and at its annual meeting in 1912 had sixty-five.

The Committee on Concrete and Reinforced Concrete presented in final form its report summarizing important achievements, which represented a great deal of concentrated effort and hard work.

The annual election resulted as follows:

John B. Lober, President

Robert S. Sinclair, Vice President

W. H. Harding, Treasurer

EXECUTIVE COMMITTEE

A. H. Craney, Jr.

T. H. Dumary

Edward M. Hagar

Richard Hardy

Robert W. Kelley

Robert W. Lesley

D. McCool

W. S. Mallory

John A. Miller

J. R. Morron

L. T. Sunderland

Frank E. Tyler

Presidency of John B. Lober 1913-1915

At a number of meetings prior to 1913, it was not uncommon for the President and Executive Committee and many members to draw particular attention to the rapid strides which the Association was making in its work, and from perusing the history of the Association thus far the reader will have recognized in it a record of true progress in every sense of the word. It was during President Lober's second incumbency that a stride more rapid than any previously recorded was made. The Executive Committee's report at the Annual Meeting in 1913 concisely summed up the year's work in the statement that never before had the Association been on such a firm basis, nor had any previous twelve months witnessed such rapid growth. Research work had progressed, the results achieved by the Publicity Committee in dissemination of literature and other educational information were marvelous, concrete roads had become a matter of absorbing interest and pointed to a promising expansion of the market for cement.

The staff of the paid Secretary had been increased from time to time and at the close of 1913 included an Assistant Secretary and several engineers, the latter designated as fieldmen. The principal work of the field staff was concrete road promotion. It was estimated that, due to their efforts, use of cement had been increased by approximately 4,000,000 barrels in 1913, with prospects that the following year would witness twice that increase.

Farm uses of concrete and concrete roads were the major subjects before the Association. Without obligation, the Association placed the services of its engineering staff at the disposal of any concern or individual requiring assistance in the solution of construction problems involving concrete. On many occasions contractors reported the saving of time and money as the result of the advisory service thus afforded. The demand for technical information, as well as practical and economical means of using concrete, increased rapidly.

In 1913, Robert W. Lesley, whose last official work as a member of the Association had been completed with the presentation of the Committee report on Uniform Cost Sheets, tendered his resignation.

In accepting this resignation, President Lober said:

The Chairman of this Committee, Robert W. Lesley, has retired after his many years of active interest in the cement business, and in so retiring, has resigned as a member of our Executive Committee. The work Mr. Lesley has accomplished for the industry is so well known to you all that it seems hardly necessary to call attention to it. He was largely instrumental in forming this Association, and was its first President. And as the years passed, and the Association increased the importance of its work, he was chosen as Chairman of its most important committees. He believed in the Association, in its usefulness to the industry, and was ever ready to give freely his time and best efforts to its work. He foresaw the important part this Association was to play in the development of our industry, and during its darkest, most discouraging times, encouraged our efforts by words and deeds. We are glad to know that he proposes to continue his active interest in the work of the Association, and that we shall still have the benefit of his advice and assistance.

Mr. Lesley was made an Honorary Member of the Association, a distinction shared later by W. S. Mallory and Norman D. Fraser.

Among the papers presented to the Association during the year was one on the subject of concrete roads by Charles J. Bennett, State Highway Commissioner of Connecticut. Mr. Bennett subsequently was responsible for building an extended system of concrete highways through that state.

The following were elected at the annual meeting:

John B. Lober, President
Robert S. Sinclair, Vice President
Charles F. Conn, Treasurer

EXECUTIVE COMMITTEE

A. H. Craney, Jr.	Richard Hardy	John R. Morron
T. H. Dumary	Robert W. Kelley	L. T. Sunderland
A. F. Gerstell	W. S. Mallory	F. E. Tyler
Edward M. Hagar	D. McCool	E. M. Young
W. H. Harding	John A. Miller	

At the close of 1914, the Association had a membership of 70 companies. It had also become firmly entrenched in the position of being regarded by technical organizations as an authority on cement and its uses.

The educational publicity work recorded further advance. Some 260 farm journals, representing more than 6,000,000 circulation, were using regular stories on the farm uses of concrete, text and illustrations for which were furnished by the Association's Publicity Bureau.

Free inspection service to highway departments and road contractors was enlarged. In an eight-months period the Association field engineers

had given inspection to 550 miles of concrete roads built during that period, involving the use of nearly 2,000,000 barrels of cement.

It was in 1914 that the Association adopted as a slogan "Concrete for Permanence."

The annual election resulted in the following:

John B. Lober, President

Robert S. Sinclair, Vice President

Charles F. Conn, Treasurer

EXECUTIVE COMMITTEE

John R. Morron

D. McCool

A. H. Craney, Jr.

E. M. Young

Edward M. Hagar

L. T. Sunderland

G. S. Brown

R. H. Hughes

F. R. Bissel

W. S. Mallory

Robert W. Kelley

F. P. Jones

F. W. Kelley

Richard Hardy

No year in the history of the Association left a more impressive record than 1915. This year also marked the conclusion of President Lober's second long term of service as leader. To President Lober more than to anyone interested in Association affairs, was the industry many times indebted for the steadfastness of purpose displayed in pointing to this group of manufacturers the way to greater things.

In 1915 the Association had a membership of 79 companies, the maximum enrollment up to that time. The dues amounted to \$210,000. In the Association membership was represented 95 per cent of the portland cement producing capacity of the country.

As those most actively concerned in the extension work of the Association gave study to the possibilities of expanding the markets for cement, it was evident everywhere that not even the surface of possibilities had been scratched. The increasing use of cement in the form of concrete roads made other heretofore neglected fields, such as the field of fire-safe construction, farm uses, and others, stand out the more conspicuously through the neglect these opportunities of expansion had suffered.

At the September meeting of the Association of this year, the Executive Committee adopted the resolution authorizing a general study of conditions in the cement industry and calling for a plan to enlarge the general educational work of the Association. A special Committee on Increased Activities was appointed and the preparation of the plan in question delegated to J. P. Beck.

During 1915, territory covered by the members of the Association was divided into so-called engineering districts, each in charge of a member of the field staff to facilitate promotional work. An office of the Association was also opened in San Francisco.

Starting with contributions in the form of educational stories to various classes of publications, followed by the development of lectures,

the educational work of the Association was supplemented by motion pictures. A scenario emphasizing the economy of concrete was presented in the form of a motion picture film under the title "The Stone of Baalbec." This film was shown in all important cities and the larger towns of the United States and proved immensely profitable from an entertainment as well as an educational viewpoint, so much so that it was subsequently followed by other films.

The administrative affairs of the Association had assumed such magnitude that the Executive Committee found it necessary to appoint an advisory committee in order that monthly meetings of this committee would enable the Executive Committee to keep in closer touch with the administrative needs of the organization.

A large amount of experimental work was being carried on under the direction of the Committee on Association Laboratory and Technical Research to determine facts on certain points raised by the Committee of the American Society for Testing Materials.

In 1915, the Association became a member of the Chamber of Commerce of the United States.

At the second day's session of the Annual meeting, Wednesday, December 16, G. S. Brown, Chairman of the special Committee on Increasing Activities of the Association, presented the Committee's report.

This was based on a plan that had been prepared by J. P. Beck and which had been submitted to all members previous to the Annual Meeting in the form of a printed book of 198 pages.

The report was adopted and in that action there was signalized a new era of Association expansion.

The annual election resulted as follows:

B. F. Affleck, President
 F. W. Kelley, First Vice President
 Richard Hardy, Second Vice President
 G. S. Brown, Treasurer

EXECUTIVE COMMITTEE

F. R. Bissell	F. P. Jones	Fred L. Muhs
H. L. Block	John B. Lober	Clark M. Moore
T. G. Dickinson	D. McCool	S. B. Newberry
John C. Eden	John A. Miller	L. T. Sunderland
R. L. Hughes	John R. Morron	E. M. Young

In assuming the Chair, President Affleck made the following remarks:

I certainly appreciate deeply the kind words which the retiring President has spoken, and in listening to him I am impressed more even than I was before with my unworthiness to succeed him, or to follow, rather, in his footsteps. I wish I could feel that there was some chance some time of my filling in the hearts of this Association the place which Mr. Lober fills. I realize, however, that that cannot, in the very nature of things, be possible. It will be my aim, however, to do the very best I can to merit the

complete confidence and loyal support of every man in the cement business. I realize that this position is one of great honor, and while I appreciate the honor to the fullest possible degree, I realize that the position is one calling for a good deal of hard work, and a good deal of personal sacrifice. We all know that Mr. Lober has done the work and made the sacrifice. I will do the same to the extent of my ability.

Presidency of B. F. Affleck 1916-1920

B. F. Affleck was born at Belleville, Illinois, in 1869. His early education was in the Belleville Grammar School.

After four years in the employ of the Harrison Machine Works, Belleville, Illinois, Mr. Affleck entered the employ of the American Express Company at St. Louis as stenographer, and later went with the St. Louis, Alton & Terre Haute Railroad, now the Illinois Central, where he remained for six years.

In 1896, he was Chief Clerk, Illinois Steel Company, St. Louis, then a salesman and later (in 1903) Sales Manager, Cement Department, Illinois Steel Company.

In 1906, the Cement Department of the Illinois Steel Company was incorporated as the Universal Portland Cement Company. Mr. Affleck was Sales Manager of this company until he became its President in 1915, which office he still holds.

The Spring Meeting of the Association in 1916, which was held in Chicago, May 8, 9 and 10, was the first gathering of the membership since it adopted the plan of increased activities. As will be noted from the dates just given, three days instead of two were allotted to the sessions.

In his opening address, President Affleck said:

In glancing through the minutes of previous meetings, I have frequently found reference to a particular meeting as "the most important one in the history of the Association," and as I read the records of the business transacted at these gatherings, I have felt that in no case could the speaker be accused of exaggeration. It has been an unusual feature of the Association that each meeting should exceed in interest and importance, every preceding one, and this fact indicates that nearly every one of our meetings is so far reaching in its results that none can be classed as the most important. The fact is that every meeting we have held since the Association was formed, nearly fourteen years ago, has been of the utmost importance in the development of the organization. Each has presented new problems and in every case the discussion of these problems has added a noteworthy page to our history.

Mr. Affleck further called attention to the fact that since the Annual Meeting in December, the membership had had opportunity to see the beginnings of the working out of the plan for enlarged activities then adopted.

During 1916, so called district activities of the Association were definitely marked by the opening of offices in Atlanta, Chicago, Dallas, Indianapolis, Kansas City, New York, Parkersburg and Pittsburgh.

The Association headquarters were transferred from Philadelphia to Chicago and J. P. Beck assumed the position of General Manager, which had been created under the extension of activities plan adopted at the preceding Annual Meeting.

An amended Constitution and By-laws became effective in 1916, recording a change in the name of the Association to Portland Cement Association. Under this new Constitution, the former Executive Committee became the Board of Directors and was empowered to appoint an Executive Committee of not more than five to manage affairs of the Association between meetings of the Board.

Another important step in 1916 was the making of a contract with the Lewis Institute, Chicago, whereby the Association at last realized a hope entertained for many years, namely, the establishment of an Association laboratory. The Lewis Institute was an endowed Institute of learning and the terms of the contract concerned the operation of the Structural Materials Research Laboratory of the Institute. Research pertaining to cement and concrete was to be conducted under an advisory committee upon which the Portland Cement Association had representation, the Association to make yearly appropriations for the operation of the laboratory. Even before entering into this arrangement with the Institute, the Association had for about a year contributed at the rate of \$8,000 per annum toward the Institute laboratory work.

In making operative the enlarged activities, the general office was more definitely departmentized than previously.

The following bureaus, departments or divisions represented the headquarters organization:

Advertising Bureau

Auditing Department

Bureau of Accident Prevention and Insurance

Cement Products Bureau

Editorial Bureau

Extension Division

 Educational Bureau

 Farm Bureau

 Lecture Bureau

 Library Bureau

 Trade Cooperation Bureau

Fireproof Construction Bureau

Road Bureau

Statistical Bureau

Structural Materials Research Laboratory

Technical Division

Uniform Cost Accounting.

The progress of Association work during 1916 was outlined in a published "Report of the President" to the membership—a printed volume of some 90 pages. In the ten months' period, January 1 to October 30, 1916, it was recorded that over 22,000,000 square yards of concrete highway pavement—roads, streets, and alleys—were placed under contract.

While not an official part of the Association's history, nevertheless the Association was in a large measure responsible for two important meetings held in Chicago, each of these being designated as a National Conference on Concrete Road Building. These conferences exerted a wider influence and interest on the part of a great number of highway engineers in the use of concrete as a highway paving material than any other one organization or agency assembled prior to this time.

In 1916, the membership established the precedent of assessing themselves *Special* dues in order to provide additional funds for more intensive promotion in various districts where the regular quota of General Dues would not permit taking full advantage of opportunities.

In December, 1915, the first paid advertising of the Association in the form of a comprehensive national schedule appeared in leading weekly and monthly magazines, farm periodicals, and the technical press. This was a part of the 1916 advertising which had been planned in connection with the increased activities of the Association. It was continued throughout 1916 and attracted marked attention toward the Association's work.

The annual election in 1916 resulted as follows:

B. F. Affleck, President

F. W. Kelley, First Vice President

Richard Hardy, Second Vice President

G. S. Brown, Treasurer

BOARD OF DIRECTORS

B. F. Affleck, Chairman

Adam L. Beck

H. L. Block

G. S. Brown

T. G. Dickinson

Richard Hardy

R. H. Hughes

C. A. Irvin

F. P. Jones

F. W. Kelley

J. W. Kittrell

John A. Miller

Clark M. Moore

John R. Morron

Fred R. Muhs

S. B. Newberry

N. S. Potter, Jr.

H. Struckmann

E. M. Young

EXECUTIVE COMMITTEE

B. F. Affleck, Chairman

H. L. Block

G. S. Brown

John R. Morron

E. M. Young

Because of the European war and the fact that this country became involved in that struggle during 1917, the Association did not hold its usual Spring Meeting.

In his opening address at the September meeting, President Affleck referred to the disturbed conditions general throughout the construction industry as follows:

The Railroad War Board at Washington has made a positive and emphatic request of all railroads to do no work which does not directly and immediately increase their capacity for moving freight. From many directions and through many mediums comes advice to economize and to refrain from unnecessary building and in some cases to refrain from all building. There has been since the middle of May, generally speaking, in most of the states throughout the country a steady and rapid falling off in demand for our product.

And on the other hand, the high and almost prohibitive cost of certain forms of steel has opened many new fields for the use of cement. Among these are ships and barges, tanks, pipe, and various other forms of construction for which plate steel has heretofore been generally used, plate steel being relatively much scarcer, more difficult to obtain, and higher in price than the forms of steel used for concrete reinforcement.

In certain sections of the country building is, and it would seem may be expected to continue, active where buildings are directly related to the manufacture or handling of various Government supplies.

The Association through various means has been very active and has accomplished results in the direction of neutralizing to a considerable extent the influences which are operating to restrict building. It has been instrumental in obtaining publication of a great many articles and editorials in technical and other magazines and papers pointing out the desirability of continuing building. It has sought in every possible way to impress upon public authorities and the public in general that, the fact that money paid for building is not spent but invested, and that road building particularly, represents no consumption of either labor or materials, but rather a conversion of the labor and materials into a form in which they are put to work serving a useful purpose for an indefinite period of time.

At this period the Government was inquiring into the cost of manufacture and selling price of cement, thus presaging control of prices. There was a feeling of pessimism tending to supplant the optimism of the previous year and there was no doubt but that cement manufacturers were confronted with many difficult problems. It became apparent that the Government would so control matters that cross-hauling of cement would be eliminated, with necessary supplies obtained by the consumer from the nearest available source, and many companies had received notice that their coal supply was likely to be cut off.

Nevertheless, the activities of the Association had increased tremendously. It was working in new fields and its several departments designed to promote the use of cement had been increased in number and enlarged as to working resources.

In 1917, additional offices of the Association were opened in Denver, Milwaukee, Minneapolis, Salt Lake City, Seattle and Washington, D. C.

The work on technical problems had advanced far beyond its previous status because of the gratifying results that had followed the co-operative arrangement with the Lewis Institute in connection with its Structural Materials Research Laboratory.

This is a proper place to record the untiring and ceaseless work of F. W. Kelley, Chairman of the Association's Committee on Technical Problems. Mr. Kelley had long centered his most active interest on the technical phases of the industry and labored for years to advance its technical side.

While actual plans were being completed for the first session of the Fall Meeting in September, J. P. Beck, the General Manager, died suddenly. H. E. Hilts, who had been long in Association employ, and who at the time was District Engineer in charge of the San Francisco Office of the Association, was appointed by the Board of Directors to succeed Mr. Beck as General Manager.

The annual election resulted as follows:

B. F. Affleck, President
 F. W. Kelley, First Vice President
 Richard Hardy, Second Vice President
 G. S. Brown, Treasurer

BOARD OF DIRECTORS

B. F. Affleck, Chairman	R. B. Henderson	John A. Miller
H. L. Block	R. H. Hughes	John R. Morron
J. W. Boardman, Jr.	C. A. Irvin	S. B. Newberry
Charles Boettcher	F. P. Jones	A. W. Shulthis
G. S. Brown	F. W. Kelley	C. E. Ulrickson
T. G. Dickinson	C. H. McNider	E. M. Young
Richard Hardy		

EXECUTIVE COMMITTEE

B. F. Affleck, Chairman	John R. Morron
G. S. Brown	E. M. Young
T. G. Dickinson	

In 1918, the Association found itself confronted with a variety of complications that had threatened it the year before. But, as President Affleck remarked in his address at the May Meeting, the Association had continued its forward stride in spite of disadvantages and was never better united nor so strong financially.

Major activities had been directed toward war-winning lines, for transportation, production, conservation and economy all pointed to the use of concrete in some form.

Both the General Office staff and field organization were handicapped to a certain extent by enlistment of many staff members in various branches of the Government's military organization. The greater number of these obtained commissions, quite a number reaching the rank of Captain and several that of Major. The Government made numerous requests of the Association for engineers and inspectors to engage in various work associated with war preparation and prosecution. Some

of these employes were requisitioned to responsible executive positions in forwarding the Government's concrete ship building plans.

Shortly before the Annual Meeting in December, the Armistice was declared. This brought the Association face to face rather suddenly with the problems of peace. The industry had suffered appreciable curtailment of business, both in volume and profit, due to necessary restrictions imposed by the Government, but the industry gladly made its contribution to the end sought.

Two additional District Offices were established in 1918, one at Detroit, and the other at Helena.

The annual report of the General Manager showed that the membership of the Association consisted of 81 companies.

Association advertising had grown considerably in a two-year period. During 1918, copy appeared in 10 leading national weeklies and monthlies, 23 trade and professional papers and 59 farm journals. This schedule involved an expenditure of \$119,059.70.

Circulation of Association literature—booklets and pamphlets promoting various uses of concrete—attained a high water mark during the year, total distribution being 2,432,520 copies. At this time the Association was publishing three regular periodicals—Concrete Highway Magazine, a monthly; Concrete Builder, and Concrete in Architecture and Engineering, both bi-monthlies. These, with fifty or more booklets, constituted the Association's stock of standard promotion literature.

Even though in the midst of war, records of the various headquarters departments, as well as District Office field organizations show that consistent planning was under way throughout the year in anticipation of the war's end.

At the Annual Meeting of the Association, W. M. Kinpey was elected by the Board of Directors to succeed H. E. Hilts as General Manager.

Considerable increase in highway activities marked 1918, several states voting large appropriations or bond issues for extensive road programs.

The annual election resulted as follows:

B. F. Affleck, President

F. W. Kelley, First Vice President

Richard Hardy, Second Vice President

G. S. Brown, Treasurer

BOARD OF DIRECTORS

B. F. Affleck, Chairman

H. L. Black

J. W. Boardman, Jr.

Charles Boettcher

G. S. Brown

T. G. Dickinson

Richard Hardy

R. B. Henderson

R. H. Hughes

C. A. Irvin

F. P. Jones

F. W. Kelley

C. H. McNider

John A. Miller

John R. Morron

S. B. Newberry

F. E. Tyler

C. E. Ulrickson

E. M. Young

EXECUTIVE COMMITTEE

B. F. Affleck, Chairman

G. S. Brown

T. G. Dickinson

John R. Morron

E. M. Young

The work of 1919 proved that returning to peace had difficulties as great as those which required adjustment for war. Stagnation in general prevailed throughout the building industry. The labor situation was bad, particularly so far as the cement industry was concerned, but in other fields also because of the wage levels that had been disturbed by war conditions.

The promotion of concrete roads by the Association had surpassed the work of previous years, contracts running over 50,000,000 square yards. But labor and contracting organizations were scarce and this condition acted as a great handicap in actual road construction.

In 1919, Association offices were opened in Des Moines, Los Angeles and St. Louis. The membership of the Association had increased to 83 companies.

During 1918, the personnel of the Association staff had been reduced to 201. With the return of many former Association employes from military and naval service and the necessity for more intensive promotional work, the staff had been increased by October 31 to 307.

At the annual meeting, the Board of Directors announced having appropriated \$10,000 to defray the expense of a National Conference on Concrete House Construction, to be held in February, 1920.

Literature distribution in 1919 totalled 2,584,104 pieces. In advertising, the Association expended \$122,101.53. This involved a schedule similar to that of the preceding year, employing 17 national weeklies and monthlies, 19 trade and professional journals, and 64 farm periodicals.

Twenty-one new publications were added to the standard stock of Association promotional literature.

The annual election resulted as follows:

B. F. Affleck, President

Richard Hardy, First Vice President

S. B. Newberry, Second Vice President

F. W. Kelley, Treasurer

BOARD OF DIRECTORS

B. F. Affleck, Chairman

George F. Bayle

J. W. Boardman, Jr.

Charles Boettcher

R. B. Dickinson

W. E. Erdell

Richard Hardy

R. B. Henderson

F. W. Kelley

Morris Kind

D. M. Kirk

C. H. McNider

D. A. Marks

John R. Morron

S. B. Newberry

B. T. Scott

F. E. Tyler

C. E. Ulrickson

E. M. Young

EXECUTIVE COMMITTEE

B. F. Affleck, Chairman
Richard Hardy
F. W. Kelley

John R. Morron
E. M. Young

Many of the difficulties which had prevailed the preceeding year remained in 1920. This made it difficult to shape the work of the Association very far in advance. Promotion plans had to be modified frequently in order that endeavors might be directed toward fields where prospective business could more easily be made a reality.

Because of continued disturbed labor conditions, the reduced purchasing power of the dollar and the unfavorable condition of foreign exchange, the financing of many projects became difficult. There was a notable cessation of awards for highway work in many states, occasioned in a large measure by the inability of cement companies and other material-producing concerns to guarantee shipments required to execute contracts. This situation was primarily due to car shortage, the high price of coal and the general unrest of labor.

The National Conference on Concrete House Construction was held in Chicago, February 17 to 19, inclusive. Registration showed that over 600 individuals attended from 36 states and Canada, as well as representatives from four European countries. The attendance included architects, builders, building commissioners, representatives of housing projects and real estate operators, in addition to those directly connected with the manufacture and distribution of cement and concrete products. All of the leading manufacturers of various concrete products were present and took active part in the deliberations of the meeting. These items in connection with the attendance are mentioned because of the very acute housing shortage which prevailed throughout the country. Primarily, the National Conference on Concrete House Construction was held because conditions seemed to make this time the most opportune that had ever occurred to attract worth-while attention and interest to the concrete house.

Before the Fall Meeting of the Association had taken place, conditions throughout the country had undergone further changes, making the usual work of the Association still more difficult. Nevertheless, the demand for cement continued beyond all precedent.

During 1920 new District Offices of the Association were opened in Portland, Oregon, and Vancouver, British Columbia.

Effective June, all Association national advertising was terminated because it seemed unlikely in view of prevailing conditions that the intended expenditure could be profitably consummated. A number of new booklets were prepared during the year. Among these was the proceedings of the National Conference on Concrete House Construction,

which was probably the most comprehensive collection of data on the application of concrete to houses that had ever been issued.

An Association committee was appointed, with Robert W. Lesley as Chairman, to consider the preparation of a "History of the Cement Industry." This Committee reported both at the September and December Meetings with outlines for the work, which were tentatively approved. The present volume is largely the result of that Committee's work.

In the report of the Board of Directors presented at the Annual Meeting, there was a tone quite the reverse of that prevailing in the year's two preceding reports of the Board. Conditions had so changed due to rapidly increasing demand and consequent growing shipments of cement that the outlook for the following year had become very encouraging. At this time more than \$1,000,000,000 had been voted by various state, county and governmental bodies, and was awaiting expenditure for various classes of highway construction—roads, streets, and alleys. Special effort on the part of the Association staff was directed toward promoting the early award of contracts for the coming year.

The annual election resulted as follows:

L. T. Sunderland, President
 Richard Hardy, First Vice President
 S. B. Newberry, Second Vice President
 F. W. Kelley, Treasurer

BOARD OF DIRECTORS

L. T. Sunderland, Chairman	R. B. Henderson	E. M. Young
Richard Hardy	John R. Morron	B. F. Affleck
F. W. Kelley	Charles Boettcher	C. Baumberger
S. B. Newberry	Morris Kind	Wm. N. Beach
George F. Bayle	C. H. McNider	W. H. Harrison
J. W. Boardman, Jr.	B. T. Scott	C. A. Irvin
R. B. Dickinson		

EXECUTIVE COMMITTEE

L. T. Sunderland, Chairman	Richard Hardy	E. M. Young
B. F. Affleck	John R. Morron	

Presidency of L. T. Sunderland 1921, 1922

L. T. Sunderland was born in 1867. He left public school at the age of fourteen to take a clerkship in a retail coal office at Ottumwa, Iowa. A year later he became manager of this concern. At sixteen he became Assistant to the Secretary and Treasurer of the Whitebreast Coal & Mining Company, Chicago.

Two years later he resigned to enter an academy at Owatonna, Minnesota. Following this, he entered the employ of the Omaha Coal,

Coke & Lime Company, which organized a branch known as L. T. Sunderland & Company in South Omaha. In 1896 this firm was changed to Sunderland Brothers Company.

In January, 1909, Mr. Sunderland accepted the position of Vice President and Manager of the Ash Grove Lime & Portland Cement Company, of which organization he was later elected President and in which position he still continues.

For many years prior to his election as President of the Association, Mr. Sunderland had been most active in furthering the Association's welfare. He was a regular attendant at meetings and always took an active part in discussions and other deliberations, in addition to serving on the Board of Directors

In accepting office, Mr. Sunderland said:

I believe the Portland Cement Association stands foremost in scope, activity and influence, and I am very proud of this unexpected honor, which has come to me wholly unsought and without my having been consulted.***

To my mind, no investment within the industry ever paid such large dividends as the money invested by members in this Association. Indeed, it is difficult to conceive how any manufacturer can withhold his support, and none will do so if he takes the trouble to inform himself as to the standing and effectiveness of this major activity.***

Nor can we who are within the membership afford to abate our interest, slacken our efforts, or diminish our contributions to the work, for by so doing we would inevitably nullify in a measure the cumulative effect of educational work already done and thus deprive ourselves of a part of the benefits for which we have already paid. Besides, we would thereby endanger to a degree the effectiveness of our future activities.

At the December Meeting, which marked the election of President Sunderland, consideration was given to the advisability of modifying the Association advertising schedule to the extent of giving preference to newspapers. This idea received approval of the Board of Directors and a schedule planned, involving the use of 172 leading newspapers, 41 farm papers, 53 trade and professional papers, and 4 general magazines. Newspapers had been under consideration in connection with the 1920 advertising schedule, but because of the uncertain conditions prevailing in the construction industry, the use of such mediums was deferred until 1921. This departure in the use of newspapers was quite unusual for an organization comparable to the Portland Cement Association. In fact, so far as is known, no similar organization had ever before carried on a national advertising campaign largely through newspapers. As might be expected, therefore, the departure attracted considerable attention and resulted in a number of articles being published in leading class periodicals, calling attention to the campaign and outlining at the same time the purposes and general work of the Association. These articles, of course, amplified the direct effect of the advertising campaign.

All records of attendance at Association meetings were broken by the registration at the May Meeting in 1921, held in Chicago, when 58 companies were represented by 171 individuals.

Probably because of the rapidly growing demand for concrete highways and the importance of cement in relation to such programs, the cement industry was kept more prominently in the public view than had previously been the case, and as mentioned by President Sunderland in his address at the May Meeting, the "industry was made the object of persistent and often vicious attacks, the charges generally resting on the assumption and allegation that cement cost little but sold for much." Consequently, it was becoming common for those identified with the cement industry to be included among those classed then as "profiteers."

Because of this trend, the Association undertook to educate the public through a series of advertisements prepared especially to set forth facts that would acquaint them with some of the problems of cement manufacture, believing that through familiarity with such problems, the public would realize that cement manufacture was a complicated and costly process involving more than grinding rock to a powder.

Notwithstanding the varied attempts to divert and undermine favorable public opinion toward the industry, the Board of Directors in its report at the September Meeting called particular attention to the continued success of Association endeavors. The times were generally marked by industrial stagnation. Nevertheless, the largest month's shipment in the history of the industry and the largest total shipments for an eight-months' period, excepting 1920, were recorded in the first eight months of 1921.

In order better to organize the general advertising and publicity work of the Association, a standing committee was appointed to supplement the talent of the Association staff with the best experience within the industry on this phase of Association activity.

A plan was approved to establish a Railway Bureau, thus relieving the Structural Bureau from promotion in that specialized field and providing for more intensive and effective cultivation of the uses of concrete by rail transportation lines.

To avoid tiresome repetition, the growth of work in several General Office or headquarters departments or bureaus has not been mentioned each year. The work of the Structural Materials Research Laboratory for a number of years had been growing apace and daily acquiring greater importance. In the matter of tests on cement, aggregate and concrete and mortar over a four-year period, the following table will give a fair idea of the large amount of work done along this line alone. This is entirely exclusive of many specialized studies, some of which require several years for conclusion.

TABLE I

KIND OF TESTS	Number of Tests Made					
	1918	1919	1920	1921	1922	1923
Cement—						
Fineness.....	277	1025	90	164	208	381
Fineness, Air Analyzer.....		320	4	23	4	
Soundness.....	198	1657	105	126	156	213
Normal Consistency.....	309	227	66	161	147	101
Time of Set.....	149	1241	500	554	339	465
Temperature Gradient.....	1041	145	168			
Unit Weight.....		152	51	50	123	175
Specific Gravity.....		48	42		78	14
Miscellaneous.....	32	9				
Aggregate—						
Sieve Analysis.....	301	290	726	572	366	440
Unit Weight.....	1820	205	911	192	270	367
Specific Gravity.....	93	74	556	6	13	15
Absorption.....	120	172	577	6	25	14
Abrasion (Deval).....	209	266	184	299	100	37
Crushing.....	597			186	44	
Colorimetric.....	77	134	387	222	242	357
Silt.....		34	344	119	367	505
Concrete and Mortar—						
Briquets.....	961	5677	1342	5196	3277	3653
2 by 4-in. cylinders.....	7380	9027	3653	10501	7883	5694
3 by 6-in. cylinders.....	1891	483	410		79	279
4 by 8-in. cylinders.....		2773	2459	1567	337	1013
5 by 10-in. cylinders.....	304				189	10
6 by 12-in. cylinders.....	10345	13767	10253	13057	11114	13939
Wear Blocks.....	1970	740	4553	1938	24	130
Indentation.....						1857
Cores.....						224
Bond.....	381	15				
Slabs (Transverse).....	41			626	40	1421
Modulus of Elasticity.....	7139	12103	5636	1474	335	454
Absorption.....	174	1157	365	1291	608	893
Slump and Flow Tests for Consistency.....		11596	5498	11184	4699	3697
Miscellaneous Physical Tests.....	1477	59	50		2235	774
Chemical Determinations.....	1422	1904	2026	4358	9469	9602

TABLE II

KIND OF TEST PIECES	Number of Tests Made					
	1918	1919	1920	1921	1922	1923
Briquets.....	975	6363	1496	7004	2845	5194
Compression Cylinders—						
2 by 4-in.....	6797	8640	4735	13618	6173	7935
3 by 6-in.....	2745				62	292
4 by 8-in.....		2116	4966	1746	6936	722
6 by 12-in.....	12007	17126	8019	14517	13716	15259
10 by 24-in. (for alkali tests).....				1550		
Wear Blocks (8 by 8 by 5 inch).....	2450	1760	4122	1360	422	130
Concrete Slabs.....	66	101		770	128	36
Miscellaneous.....	108				1857	1583

As a natural consequence of tests such as have been listed in the preceding tables, the laboratory has issued a number of bulletins. Such bulletins have appeared under the titles in the following list.

LIST OF PUBLICATIONS OF THE
STRUCTURAL MATERIALS RESEARCH LABORATORY

April, 1924

BULLETIN 1. Design of Concrete Mixtures, by Duff A. Abrams (1918).

Discusses the effect of quantity of mixing water, and size and grading of aggregates on the compressive strength of concrete. Outlines a new method of design of concrete mixtures.

BULLETIN 2. Effect of Curing Condition on the Wear and Strength of Concrete, by Duff A. Abrams.

Reprinted from Proc. Am. Railway Eng. Assn., v. 20, 1919.

Tests show benefit to strength and resistance to wear from keeping concrete moist, as compared with allowing it to dry out prematurely.

Discusses relation between wear and strength and gives data on absorption and unit weight of concrete. Bibliography revised to 1922.

BULLETIN 3. Effect of Vibration, Jigging and Pressure on Fresh Concrete, by Duff A. Abrams.

Reprinted from Proc. Am. Concrete Inst. v. 15, 1919.

Tests show the effect of vibration, jigging and pressure on the compressive strength of concrete cylinders.

BULLETIN 4. Effect of Fineness of Cement, by Duff A. Abrams; Revised, 1922.

Reprinted from Proc. Am. Soc. Testing Mat., v. 19, Part II, 1919.

Concrete and mortar tests on 51 samples of cement from 7 different mills, ground to finenesses ranging from 2 to 43 per cent on the 200-mesh sieve. Also gives numerous data on strength of concrete of different mixes, consistencies, etc., at ages of 7 days to 1 year.

BULLETIN 5. Modulus of Elasticity of Concrete, by Stanton Walker; Revised, 1923.

Reprinted from Proc. Am. Soc. Testing Mat., v. 19, Part II, 1919.

Discussion of stress-deformation measurements on about 4,000 6 by 12-inch concrete cylinders and relation between modulus of elasticity and strength. Derives constants for concrete of a wide range of mixtures, consistencies, and ages up to 5 years. Numerous general data on the strength of concrete are given. Appendices on flexure of reinforced concrete beams and bibliography.

BULLETIN 6. Effect of Storage of Cement, by Duff A. Abrams; Revised, 1924.

Cement in cloth sacks stored in shed in yard and in laboratory for periods up to about 5 years; parallel tests made using paper sacks for certain conditions. Mortar and concrete tests made at ages of 7 days to 2 years after each storage period.

BULLETIN 7. Effect of Tannic Acid on the Strength of Concrete, by Duff A. Abrams.

Reprinted from Proc. Am. Soc. Testing Mat., v. 20, Part II, 1920.

Tannic acid in different proportions used as typical of organic impurities encountered in natural sands. Compression tests of 3 by 6-inch concrete cylinders of different mixtures, consistencies, and grading of aggregates at ages of 7 days to 2 years.

BULLETIN 8. Effect of Hydrated Lime and Other Powdered Admixtures in Concrete, by Duff A. Abrams.

Reprinted from Proc. Am. Soc. Testing Mat. v. 20, Part II, 1920.

An exhaustive study of the effect of hydrated lime and other inert powdered admixtures in concrete. Wear and strength tests cover a wide range of mixes, consistencies, sizes and gradings of aggregates, ages, curing conditions, etc.

BULLETIN 9. Quantities of Materials for Concrete, by Duff A. Abrams and Stanton Walker (1921).

A series of tables giving the proportions and quantities of materials required to produce concrete having a compressive strength of 1,500, 2,000, 2,500, 3,000, 3,500 and 4,000 lb. per sq. in., using fine and coarse aggregates of different sizes, and tested in accordance with standard methods at age of 28 days.

BULLETIN 10. Wear Test of Concrete, by Duff A. Abrams.

Reprinted from Proc. Am. Soc. Testing Mat., v. 21, 1921.

Gives the result of wear and compression tests of concrete made with a variety of coarse aggregates. The effect of amount of mixing water and cement, curing condition, and grading of aggregate on wear is discussed in detail. The intimate relation between wear and strength of concrete is pointed out.

BULLETIN 11. Flexural Strength of Plain Concrete, by Duff A. Abrams.

Reprinted from Proc. Am. Concrete Inst., v. 18, 1922.

Gives the results of tests showing the effect of quantity of cement, mixing water, age, curing condition, etc., on flexural strength of concrete. Shows the relation of flexural strength to compressive strength. Data are also given showing the effect of depth and position of beam and of small quantities of reinforcement.

CIRCULAR 1. Colorimetric Test for Organic Impurities in Sands, by Duff A. Abrams and Oscar E. Harder (1917).

Out of print.

For a more recent discussion of this subject see "Abrams-Harder Field Test for Organic Impurities in Sands." Proc. Am. Soc. Testing Mat., 1919, Part I; also "Tentative Method of Test for Organic Impurities in Sands for Concrete," Proc. Am. Soc. Testing Mat., 1921.

The report of the Committee on Advertising and Publicity, presented at the Annual Meeting, recommended a more expanded advertising campaign in 1922 than had previously been carried on. It presented a plan in which the use of newspapers dominated. The initial experiment of newspaper advertising the preceding year had promised such possibilities from the standpoint of correcting erroneous public opinion concerning the industry that it seemed advisable to expand on this effort.

In summing up the work of the year, the Board of Directors in its report said "records of shipments, production, yardage of concrete pavements awarded and constructed, and even attendance at meetings have been broken this year."

The annual election resulted as follows:

L. T. Sunderland, President
 Richard Hardy, First Vice President
 S. B. Newberry, Second Vice President
 F. W. Kelley, Treasurer

BOARD OF DIRECTORS

L. T. Sunderland, Chairman	B. T. Scott	C. A. Irvin
Richard Hardy	E. M. Young	H. L. Block
F. W. Kelley	B. F. Affleck	Geo. T. Cameron
S. B. Newberry	C. Baumberger	Chas. F. Conn
Charles Boettcher	W. N. Beach	Wm. M. Hatch
Morris Kind	David M. Kirk	H. Struckmann
C. H. McNider		

EXECUTIVE COMMITTEE

L. T. Sunderland, Chairman	
B. F. Affleck	B. T. Scott
Richard Hardy	E. M. Young

The initial effort made in 1921 to disseminate facts about the portland cement industry and the relation of the Association to the industry promised such desirable results that 1922 saw this campaign enlarged upon. A new bureau at the General Office of the Association was organized to carry on a work of general education of the public. This bureau was later designated as the General Educational Bureau.

Compilation of facts and figures showing the importance of the industry from the standpoint of its interrelation with other industries was made by the General Educational Bureau and such data were used as the basis of advertising copy, and in a series of bulletins issued under the heading "Information about Cement." During the year something like 1,500,000 copies of these bulletins were distributed.

The advertising schedule of the Association was expanded, preference, as during the year previous, being given to newspapers. Special effort was directed toward placing in the hands of publishers of all classes of periodicals, facts concerning the industry in order that news and editorial matter might better reflect an intelligent understanding of the industry when it, or related interests, was under discussion.

During the year a total of slightly more than 3,000,000 pieces of printed matter—promotional booklets and "Information about Cement" bulletins—were distributed.

The banner year in cement shipments proved to be 1922, the total being 117,701,216 barrels, which was more than 22,000,000 barrels in excess of the best previous year. This unprecedented demand for cement might be taken as an indication that people had become tired of the unsettled conditions in the building industry that had prevailed for several

years previous and had decided to go ahead, regardless of so-called "conditions." The results were contributed to in no small measure by the signs of recovery from Government control that were being displayed by railroads in the increasing volume of traffic moved.

During the year various General Office bureaus and District Offices directed greater promotion effort to fields involving the use of concrete where the extension of such use had not previously been aggressively carried on. Promotion aid in these new fields was given in part by between thirty and forty new publications, revision of a number of standard ones and a considerable list of reprints from other publications.

Encouraging advance was recorded in the effort to promote concrete for house construction.

District Offices were established in Boston and Philadelphia.

The total number of employees in 1921 was 310; in 1922 the total was 336.

While the Association strictly adheres to the policy of having nothing to do with the commercial side of the industry, it took an advance step in 1922 which immeasurably enhanced its standing and prestige with the public. This step constituted an amendment to the By-Laws, providing that membership in the Association should be contingent upon members' product meeting accepted engineering standards.

Thus, although the Portland Cement Association could not at any time guarantee the product of its members, it could point with pride to a group of manufacturers, every one of whom would jealously safeguard its membership by producing only a quality product.

No doubt this amendment to the By-Laws resulted from the fact that on March 31, 1922, the various bodies which had been working to bring about a standard specification for cement completed their labors in seeing the first American standard specification adopted by the American Engineering Standards Committee. The United States Government specification had exactly the same requirements, thus resulting in common accord on a subject which had long been a confusing and disturbing one to manufacturers and users of cement alike. Thus ended a work, which, as mentioned in the History of the Portland Cement Industry, had its inception in a Committee of the American Society of Civil Engineers in 1884.

In the fall of 1922, President Sunderland announced he would not be a candidate for re-election. In his closing address to the Association at the Annual Meeting, he urged a continuance of the general educational activities as organized under the new department previously mentioned and increase of expenditures for the purpose, if necessary, to attain the objective, saying: "Our industry's need of correct public interpretation has been fully demonstrated. However difficult and costly to manu-

facture, unless the public knows the facts, it will assume that cement is only pulverized rock; * * * * Unless the public is kept correctly informed, the industry will be constantly subject to attack, thereby damaging our business and destroying our prestige and influence. * * * * There can be no doubt, however, that our campaign of education has already turned the tide of public interest in our favor for the people are vitally interested in the facts concerning the conduct of any industry to which they contribute, and whose economic importance assumes such vast importance as that of this industry."

The annual election resulted in the following:

F. W. Kelley, President
Blaine S. Smith, First Vice President
L. R. Burch, Second Vice President
E. M. Young, Treasurer

BOARD OF DIRECTORS

F. W. Kelley, Chairman	David M. Kirk	H. Struckmann
L. R. Burch	C. A. Irvin	C. B. Condon
Blaine S. Smith	H. L. Block	Carl Leonardt
E. M. Young	George T. Cameron	W. D. Lober
B. F. Affleck	Chas. F. Conn	Frank H. Smith
W. N. Beach	Wm. M. Hatch	L. T. Sunderland
Loring A. Cover		

EXECUTIVE COMMITTEE

F. W. Kelley, Chairman	
B. F. Affleck	L. T. Sunderland
L. R. Burch	E. M. Young

Presidency of F. W. Kelley 1923, 1924

Frederick W. Kelley was born in Albany, New York, December 15, 1870.

His early education was received at the Albany, New York, Academy and Toledo, Ohio, public schools. In 1893 he was graduated from Cornell University with the degree of mechanical engineer.

From 1893 to 1900 inclusive Mr. Kelley was employed successively as experimental engineer, shop manager, general manager and treasurer, of the Consolidated Car Heating Company, Albany, New York.

In 1900, he became Vice President and General Manager of Helderberg Cement Company, Albany, New York, being elected president as well as general manager of that company in 1914.

Few people who have been actively identified with the cement industry for the past twenty or more years have taken a more active part in advancing the scientific and technical side of the industry than Mr. Kelley.

Before 1923 had advanced very far, it was recorded that production and shipments of portland cement for the first four months of the year as reported by the U. S. Geological Survey exceeded those of any similar period in the past. When the complete figures for the year had been issued by the Government, they showed total shipments of 135,887,000 barrels.

For several years the Association had been exerting an effort toward having highway contracts awarded early, thus paving the way for the early placing of orders for cement requirements. This, and continued campaigns to encourage all the year building, no doubt resulted in sustaining the demand for cement, as was evidenced by uninterrupted building activity in many fields.

The general educational work was continued.

The high watermark in expenditure for paid advertising occurred in 1923, the total being approximately \$450,000. In addition to a newspaper campaign, advertising appeared in the Saturday Evening Post, the Literary Digest, the Quality Group, and a large number of trade and professional papers.

During Better Homes Week, June 4 to 10, there was dedicated and opened to public inspection a replica of the John Howard Payne "Home Sweet Home" house, built on a plot adjacent to the White House at Washington. Ground was broken by Secretary Hoover, April 23, and through the efforts of an Association representative, acting as Director of Construction, walls, rough floor, and roof were completed one week later. The cornerstone was laid by the President of the National Federation of Women's Clubs and President Harding officially opened the house June 4. This house was built of concrete block with portland cement stucco finish. This project, because of the nation-wide interest in home building, received a great deal of valuable publicity, was made the subject of a motion picture film, and in various other ways was kept continually before the public through advertising, etc. Later, the house was moved to a permanent site and is now the national headquarters of the Girl Scouts of America.

Additional District Offices of the Association were opened during 1923 in Birmingham, Jacksonville, Memphis and New Orleans. The total number of employes on the Association payroll at the end of July, 1923, was 367.

As the result of intensified concrete house promotion, great strides in the use of concrete products for home building were noted, particularly in the states covered by the New York and Philadelphia offices of the Association. Through Association cooperation and encouragement, many new plants were established for the manufacture of high grade concrete structural units and the standards and capacity of established plants proportionately increased.

Everywhere it became evident that concrete was being favored more than ever for such large structures as hotels, apartment houses, theaters, schools, and similar public or semi-public buildings. This evidenced an increasing familiarity on the part of architects and engineers with the peculiar merits and distinctive adaptability of concrete.

One outstanding feature of all Association field work in 1923 was the endeavor to make it a quality year. With the ever-increasing demand for cement, it became evident that greater attention should be directed toward assisting others to secure the utmost from their investment in the material in order that the product through misuse or abuse would not discredit itself. A great deal of time was therefore directed toward cooperating with officials in inspecting work to make sure of the highest standards of construction.

Educational bulletins setting forth various information and facts about cement and the industry were prepared and distributed, the total circulation of such literature being in excess of 3,000,000 copies. Among other educational aids were exhibits prepared to illustrate the manufacture of cement. These were shown at various national conventions and were on exhibition in the display windows of banks, newspaper offices, and elsewhere.

The annual election resulted as follows:

F. W. Kelley, President

Blaine S. Smith, First Vice President

L. R. Burch, Second Vice President

J. W. Boardman, Treasurer

BOARD OF DIRECTORS

F. W. Kelley, Chairman

J. W. Boardman

L. R. Burch

Blaine S. Smith

H. L. Block

George T. Cameron

Chas. F. Conn

Wm. M. Hatch

H. Struckmann

C. B. Condon

Carl Leonardt

W. D. Lober

Frank H. Smith

L. T. Sunderland

Adam L. Beck

F. R. Kanengeiser

F. G. McKelvy

F. L. Williamson

E. M. Young

EXECUTIVE COMMITTEE

F. W. Kelley, Chairman

L. R. Burch

Blaine S. Smith

L. T. Sunderland

E. M. Young

Officers and Directors of Portland Cement Association

By Years

1902—Robert W. Lesley, President
 John B. Lober, Vice President
 A. F. Gerstell, Secretary
 E. M. Young, Treasurer

Executive Committee

E. R. Ackerman
 G. E. Bartol
 T. H. Dumary
 W. H. Harding
 W. W. Maclay
 H. W. Maxwell
 W. R. Warren

1903—John B. Lober, President
 A. F. Gerstell, Vice President
 E. M. Young, Secretary
 E. R. Ackerman, Treasurer

Executive Committee

Executive Committee

T. J. Brady
 T. H. Dumary
 A. F. Gerstell
 Edward M. Hagar
 W. H. Harding
 Robert W. Lesley
 Duane Millen
 Conrad Miller
 S. B. Newberry
 W. J. Prentice
 W. R. Warren
 E. M. Young

1906—John B. Lober, President
 C. F. Wade, Vice President
 E. R. Ackerman, Treasurer

On this and the following pages Officers and
 Directors are listed as of the years in which
 elected.

W. H. Harding
 Robert W. Lesley
 W. W. Maclay
 D. McCool
 S. B. Newberry
 C. P. Wade
 W. R. Warren
 E. M. Young

1905—John B. Lober, President
 C. F. Wade, Vice President
 E. R. Ackerman, Treasurer

Executive Committee

T. H. Dumary
 N. D. Fraser
 A. F. Gerstell
 W. H. Harding
 J. W. Kittrell
 Robert W. Lesley
 W. S. Mallory
 Conrad Miller
 G. E. Nicholson
 W. R. Warren
 L. M. Wing
 E. M. Young

Officers and Directors of Portland Cement Association

By Years

1902—Robert W. Lesley, President

John B. Lober, Vice President

A. F. Gerstell, Secretary

E. M. Young, Treasurer

Executive Committee

E. R. Ackerman

G. E. Bartol

T. H. Dumary

W. H. Harding

W. W. Maclay

H. W. Maxwell

W. R. Warren

1903—John B. Lober, President

A. F. Gerstell, Vice President

E. M. Young, Secretary

E. R. Ackerman, Treasurer

Executive Committee

G. E. Bartol

Edward M. Hagar

W. H. Harding

Robert W. Lesley

H. W. Maxwell

S. B. Newberry

W. R. Warren

1904—John B. Lober, President

A. F. Gerstell, Vice President

E. R. Ackerman, Treasurer

Executive Committee

S. H. Bassett

T. J. Brady

T. H. Dumary

Edward M. Hagar

W. H. Harding

Robert W. Lesley

W. W. Maclay

D. McCool

S. B. Newberry

C. P. Wade

W. R. Warren

E. M. Young

1905—John B. Lober, President

C. F. Wade, Vice President

E. R. Ackerman, Treasurer

Executive Committee

T. J. Brady

T. H. Dumary

A. F. Gerstell

Edward M. Hagar

W. H. Harding

Robert W. Lesley

Duane Millen

Conrad Miller

S. B. Newberry

W. J. Prentice

W. R. Warren

E. M. Young

1906—John B. Lober, President

C. F. Wade, Vice President

E. R. Ackerman, Treasurer

Executive Committee

T. H. Dumary

N. D. Fraser

A. F. Gerstell

Edward M. Hagar

W. H. Harding

Robert W. Lesley

Duane Millen

Conrad Miller

S. B. Newberry

G. E. Nicholson

W. R. Warren

E. M. Young

1907—John B. Lober, President

Edward M. Hagar, Vice Pres

E. R. Ackerman, Treasurer

Executive Committee

T. H. Dumary

N. D. Fraser

A. F. Gerstell

W. H. Harding

J. W. Kittrell

Robert W. Lesley

W. S. Mallory

Conrad Miller

G. E. Nicholson

W. R. Warren

L. M. Wing

E. M. Young

1908—John B. Lober, President
Edward M. Hagar, Vice President
E. R. Ackerman, Treasurer

Executive Committee

E. R. Ackerman
George S. Bartlett
T. H. Dumary
N. D. Fraser
A. F. Gerstell
Edward M. Hagar
W. H. Harding
J. W. Kittrell
Robert W. Lesley
John B. Lober
W. S. Mallory
Conrad Miller
G. E. Nicholson
L. M. Wing
E. M. Young

1909—W. S. Mallory, President
Edward M. Hagar, Vice President
E. R. Ackerman, Treasurer

Executive Committee

George S. Bartlett
Bethune Duffield
T. H. Dumary
A. F. Gerstell
W. H. Harding
Robert W. Kelley
Robert W. Lesley
Conrad Miller
G. E. Nicholson
E. M. Young
C. H. Zehnder

1910—Edward M. Hagar, President
W. S. Mallory, Vice President
John B. Lober, Treasurer

Executive Committee

E. R. Ackerman
George S. Bartlett
A. H. Craney, Jr.
Bethune Duffield
T. H. Dumary
Robert W. Kelley
Robert W. Lesley
Conrad Miller
John R. Morron
S. B. Newberry
G. E. Nicholson
C. H. Zehnder

1911—Edward M. Hagar, President
W. S. Mallory, Vice President
John B. Lober, Treasurer

Executive Committee

A. H. Craney, Jr.
Bethune Duffield
T. H. Dumary
Edward M. Hagar
W. H. Harding
Robert W. Kelley
Robert W. Lesley
John B. Lober
W. S. Mallory
Conrad Miller
John R. Morron
S. B. Newberry
Whitney Newton
G. E. Nicholson
C. H. Zehnder

1912—John B. Lober, President
R. S. Sinclair, Vice President
W. H. Harding, Treasurer

Executive Committee

A. H. Craney, Jr.
T. H. Dumary
Edward M. Hagar
Richard Hardy
Robert W. Kelley
Robert W. Lesley
D. McCool
W. S. Mallory
John A. Miller
John R. Morron
L. T. Sunderland
F. E. Tyler

1913—John B. Lober, President
R. S. Sinclair, Vice President
Chas. F. Conn, Treasurer

Executive Committee

A. H. Craney, Jr.
T. H. Dumary
A. F. Gerstell
Edward M. Hagar
W. H. Harding
Richard Hardy
Robert W. Kelley
W. S. Mallory
D. McCool
John A. Miller

John R. Morron
L. T. Sunderland
F. E. Tyler
E. M. Young

1914—John B. Lober, President
R. S. Sinclair, Vice President
Chas. F. Conn, Treasurer

Executive Committee

F. R. Bissell
G. S. Brown
A. H. Craney, Jr.
Edward M. Hagar
Richard Hardy
R. H. Hughes
F. P. Jones
F. W. Kelley
Robert W. Kelley
D. McCool
W. S. Mallory
John R. Morron
L. T. Sunderland
E. M. Young

1915—B. F. Affleck, President
F. W. Kelley, First Vice President
Richard Hardy, Second Vice President
G. S. Brown, Treasurer

Executive Committee

F. R. Bissell
H. L. Block
T. G. Dickinson
John C. Eden
R. L. Hughes
F. P. Jones
John B. Lober
D. McCool
John A. Miller
Clark M. Moore
John R. Morron
Fred L. Muhs
S. B. Newberry
L. T. Sunderland
E. M. Young

1916—B. F. Affleck, President
F. W. Kelley, First Vice President
Richard Hardy, Second Vice President
G. S. Brown, Treasurer

Board of Directors

B. F. Affleck, Chairman
A. L. Beck
H. L. Block
G. S. Brown
T. G. Dickinson
Richard Hardy
R. H. Hughes
C. A. Irvin
F. P. Jones
F. W. Kelley
J. W. Kittrell
John A. Miller
Clark M. Moore
John R. Morron
Fred R. Muhs
S. B. Newberry
N. S. Potter, Jr.
H. Struckmann
E. M. Young

Executive Committee

B. F. Affleck, Chairman
H. L. Block
G. S. Brown
John R. Morron
E. M. Young

1917—B. F. Affleck, President
F. W. Kelley, First Vice President
Richard Hardy, Second Vice President

G. S. Brown, Treasurer

Board of Directors

B. F. Affleck, Chairman
H. L. Block
J. W. Boardman, Jr.
Charles Boettcher
G. S. Brown
T. G. Dickinson
Richard Hardy
R. B. Henderson
R. H. Hughes
C. A. Irvin
F. P. Jones
F. W. Kelley
C. H. McNider
John A. Miller
John R. Morron
S. B. Newberry
A. W. Shulthis
C. E. Ulrickson
E. M. Young

Executive Committee

B. F. Affleck, Chairman
G. S. Brown
T. G. Dickinson
John R. Morron
E. M. Young

1918—B. F. Affleck, President
F. W. Kelley, First Vice President
Richard Hardy, Second Vice President
G. S. Brown, Treasurer

Board of Directors

B. F. Affleck, Chairman
H. L. Block
J. W. Boardman, Jr.
Charles Boettcher
G. S. Brown
T. G. Dickinson
Richard Hardy
R. B. Henderson
R. H. Hughes
C. A. Irvin
F. P. Jones
F. W. Kelley
C. H. McNider
John A. Miller
John R. Morron
S. B. Newberry
F. E. Tyler
C. E. Ulrickson
E. M. Young

Executive Committee

B. F. Affleck, Chairman
G. S. Brown
T. G. Dickinson
John R. Morron
E. M. Young

1919—B. F. Affleck, President
Richard Hardy, First Vice President
S. B. Newberry, Second Vice President
F. W. Kelley, Treasurer

Board of Directors

B. F. Affleck, Chairman
George F. Bayle
J. W. Boardman, Jr.
Charles Boettcher
R. B. Dickinson

W. E. Erdell
Richard Hardy
R. B. Henderson
F. W. Kelley
Morris Kind
David M. Kirk
C. H. McNider
D. A. Marks
John R. Morron
S. B. Newberry
B. T. Scott
F. E. Tyler
C. E. Ulrickson
E. M. Young

Executive Committee

B. F. Affleck, Chairman
Richard Hardy
F. W. Kelley
John R. Morron
E. M. Young

1920—L. T. Sunderland, President
Richard Hardy, First Vice President
S. B. Newberry, Second Vice President
F. W. Kelley, Treasurer

Board of Directors

L. T. Sunderland, Chairman
B. F. Affleck
C. Baumberger
George F. Bayle
Wm. N. Beach
J. W. Boardman, Jr.
Charles Boettcher
R. B. Dickinson
Richard Hardy
W. H. Harrison
R. B. Henderson
C. A. Irvin
F. W. Kelley
Morris Kind
C. H. McNider
John R. Morron
S. B. Newberry
B. T. Scott
E. M. Young

Executive Committee

L. T. Sunderland, Chairman
B. F. Affleck

Richard Hardy
John R. Morron
E. M. Young

- 1921—L. T. Sunderland, President
Richard Hardy, First Vice
President
S. B. Newberry, Second Vice
President
F. W. Kelley, Treasurer

Board of Directors

L. T. Sunderland, Chairman
B. F. Affleck
C. Baumberger
W. N. Beach
H. L. Block
Charles Boettcher
Geo. T. Cameron
Chas. F. Conn
Richard Hardy
Wm. M. Hatch
C. A. Irvin
F. W. Kelley
Morris Kind
David M. Kirk
C. H. McNider
S. B. Newberry
B. T. Scott
H. Struckmann
E. M. Young

Executive Committee

L. T. Sunderland, Chairman
B. F. Affleck
Richard Hardy
B. T. Scott
E. M. Young

- 1922—F. W. Kelley, President
Blaine S. Smith, First Vice
President
L. R. Burch, Second Vice
President
E. M. Young, Treasurer

Board of Directors

F. W. Kelley, Chairman
B. F. Affleck
W. N. Beach
H. L. Block
L. R. Burch
Geo. T. Cameron
C. B. Condon

Chas. F. Conn
Loring A. Cover
Wm. M. Hatch
C. A. Irvin
David M. Kirk
Carl Leonardt
W. D. Lober
Blaine S. Smith
Frank H. Smith
H. Struckmann
L. T. Sunderland
E. M. Young

Executive Committee

F. W. Kelley, Chairman
B. F. Affleck
L. R. Burch
L. T. Sunderland
E. M. Young

- 1923—F. W. Kelley, President
Blaine S. Smith, First Vice
President
L. R. Burch, Second Vice
President
J. W. Boardman, Treasurer

Board of Directors

F. W. Kelley, Chairman
Adam L. Beek
H. L. Block
J. W. Boardman
L. R. Burch
Geo. T. Cameron
C. B. Condon
Chas. F. Conn
Wm. M. Hatch
F. R. Kanengeiser
Carl Leonardt
W. D. Lober
F. G. McKelvy
Blaine S. Smith
Frank H. Smith
H. Struckmann
L. T. Sunderland
F. L. Williamson
E. M. Young

Executive Committee

F. W. Kelley, Chairman
L. R. Burch
Blaine S. Smith
L. T. Sunderland
E. M. Young

APPENDIX B

HISTORY OF THE PORTLAND CEMENT INDUSTRY BY YEARS

This appendix assembles the more important developments in the portland cement industry as found in the annual reports of the United States Geological Survey and "The Mineral Industry" of the United States. The period covered is from 1870 to 1923, inclusive, thus covering the American industry from the beginning.

YEARS 1870-1879

Years	Barrels	Value	Average Factory Price per Bbl.
1870-1879	82,000	\$246,000	\$3.00

In dealing with the production and value of portland cement, the Government has grouped the years from 1870 to 1879, fixing output and value as given above.

During this period, pioneer portland cement plants had been established by David O. Saylor, Allentown, Pennsylvania; Thomas Millen, South Bend, Indiana; John K. Shinn, Wampum, Pennsylvania.

YEAR 1880

Year	Barrels	Value	Average Factory Price per Bbl.
1880	42,000	\$126,000	\$3.00

The official estimate of production and value for 1880 is given as above. That little interest attached to portland cement during the first decade of its manufacture is revealed by these early Government reports. One published in 1883 summarizes the cement industry of the United States as follows:

The total cement production of the country in 1882 is estimated by the best authorities at from 3,000,000 to 3,500,000 barrels. Of this, 85,000 barrels, of 400 pounds each, are estimated to be the production of artificial or portland cement. The average price of this is about \$2.25 at the works.

Further along the report discusses the Rosendale and Louisville natural cement districts, but on the subject of the Lehigh district, the

cradle of the portland cement industry, says that "both natural and artificial cements are manufactured to a considerable extent at Allentown, Pennsylvania."

Companies organized in 1880:

Alamo Portland & Roman Cement Company, San Antonio, Texas.

YEARS 1881-1884

Years	Barrels	Value	Average Factory Price per Bbl.
1881	60,000	\$150,000	\$2.50
1882	85,000	191,250	2.01
1883	90,000	193,500	2.15
1884	100,000	210,000	2.10

The text accompanying the figures given above refers to "Egypt, Pennsylvania, and Coplay (near Allentown), Pennsylvania," as the "leading localities" engaged in the manufacture of "artificial cement," the name given portland cement at the time. Reference is made to the significance of growing importations of portland cement, which is described as superior to the domestic product in both setting and lasting qualities when kept up to standard, but competition had resulted in the importation of cement of a quality much inferior to even the poorest of the home products. In this statement is revealed the beginning of a short-sighted policy on the part of foreign manufacturers. The average price of imported cement per barrel of 400 pounds, laid down on the pier at New York, in 1882-3-4, was \$2.60, \$2.70 and \$2.50 respectively. In 1884 imports at New York amounted to 356,562 barrels of cement in 1877, 58,500 barrels, beginning in 1864 with about 13,000 barrels. It is stated that with only one exception, a continental brand, the imported cements were "artificial."

Companies organized in 1883:

American Improved Cements Company, Philadelphia (subsequently the American Cement Company, predecessor of the Giant Portland Cement Company.)

In 1884 a plant was established at Oregon City, Oregon.

YEAR 1885

Year	Barrels	Value	Average Factory Price per Bbl.
1884	100,000	\$210,000	\$2.10
1885	150,000	292,500	1.95

Increased production with lower prices marked the situation in 1885. While the great bulk of portland cement was produced in the vicinity of Allentown, "a fair quantity," as the Government statisticians put it, was

manufactured in South Bend, Indiana. It was stated that the makers of this cement were not seeking an open market but using it for local consumption in the manufacture of sewer pipe, etc. The foregoing refers, of course, to the Millen plant, although the name is not mentioned.

In attempting to prepare accurate data on the subject of cement in general the Government representatives complained that "a great deal of reticence developed at every attempt to reach an exact figure."

Further increase in importations took place in 1885. Concerning developments of the year, the following significant statement was made:

Portland cements are receiving some very critical scientific attention and their properties are becoming better understood than any other similar products, a suggestion that might be taken into account by the manufacturers of domestic cements.

Then follow the conclusions of an English scientist concerning proper tests to determine the requisites of a first-class cement. Soundness required that a pat made and submitted to moist heat and warm water should show no signs of "blowing" in twenty-four hours. In fineness all of the cement was to pass through a sieve having 625 holes (25 by 25) to the square inch and have only 10 per cent residue when sifted through a sieve having 2,500 holes (50 by 50) to the square inch. Tensile tests without fracture were to meet 175 pounds in three days, 50 per cent increase in seven days over strength shown at three days, and the briquettes when broken at the seven days' test had to carry average tensile strain without fracture of at least 350 pounds per square inch.

Companies incorporated in 1885:

Eagle Portland Cement Company, Kalamazoo, Michigan.

YEAR 1886

Year	Barrels	Value	Average Factory Price per Bbl.
1885	150,000	\$292,500	\$1.95
1886	150,000	292,500	1.95

The estimated production and value of portland cement in 1886 was merely a repetition of 1885 figures, but expansion of the industry was noted, accompanied by the statement that improved machinery and methods of manufacture were in evidence so that successful competition with foreign producers was becoming more and more favorable to American manufacturers. Reference was made to the higher cost of labor in the United States, but American inventive genius was relied upon to offset this through improved machinery. It was predicted that the industry would increase with rapid strides during the next few years.

An interesting statement was to the effect that demand for better mortar was becoming very pronounced, "as lime mortar, requiring external influences in the setting process, does not contract uniformly on

both sides of a wall, one side being exposed and the other protected," whereas "cement containing within itself all the elements necessary to the setting process, is not open to this objection."

Demand for cement had led to increased facilities at the Millen plant, and in recognition of the growing importance of the industry, the United States Geological Survey report of that year included extracts from a paper on the manufacture of portland cement read before the Engineers' Club of Philadelphia, by Robert W. Lesley, and also extracts from an article on the Ransome improvements in manufacture, written by R. J. Friswell, and published in the London Engineer.

It was in this year that Jose F. de Navarro and his two sons erected at the plant of the Union Cement Company, Rondout, New York, the first rotary cylinder or kiln used for cement burning in this country.

YEAR 1887

Year	Barrels	Value	Average Factory Price per Bbl.
1886	150,000	\$292,500	\$1.95
1887	250,000	487,500	1.95

The most interesting historic fact announced in 1887 was as follows:

The first attempt in the United States to use the Ransome process of burning and grinding cement has just been made by the Portland Cement Company of Portland, Oregon. These works have just commenced operations and are located at Oregon City, Clackamas County. The material used is a natural portland cement rock found in Douglas County, Oregon, and is said to be unlimited in quantity. The Ransome revolving cylinder is used, and the natural material is burned in a powdered state, using an ordinary gas producer to furnish gas as fuel, which is burned in the cylinder simultaneously supplied with air, the heat being thus under perfect control. The abundant water power of the Willamette River is utilized. The works now have a capacity for producing 30,000 barrels of cement per annum, but this capacity can be tripled by the addition of only the necessary grinding mills.

The manufacture in England of three kinds of blast-furnace slag cement attracted attention in 1887, one variety being described as stronger than portland cement and showing improvement with age.

YEAR 1888

Year	Barrels	Value	Average Factory Price per Bbl.
1887	250,000	\$487,500	\$1.95
1888	250,000	487,500	1.95

Estimated production and value for 1888 showed no change from the figures of the preceding year. Attention was called to large quantities of raw material suitable for manufacture in the vicinity of Charleston. In the way of scientific comment on cement in general, extracts are quoted

from a paper on testing by A. Marichal read before the Engineers' Club of Philadelphia, in which he is quoted as saying that tests of pure cement alone are entirely useless, and that relative values are determined with different proportions of sand. The author deplored the fact that "compressive strength could not be ascertained with any degree of accuracy, as the cement was injured before it was crushed."

YEARS 1889-1890

Year	Barrels	Value	Average Factory Price per Bbl.
1889	300,000	\$500,000	\$1.67
1890	335,500	704,050	2.09

The cement reports of the United States Geological Survey for the years 1889-1890 refer to the adaptability to portland cement manufacture of a remarkable deposit of cement rock discovered in 1890 near South Riverside, California, the area of which was 330 acres and its depth 90 feet, the whole capped by from 3 to 5 feet of limestone.

In July, 1889, an exact duplicate of the Ransome kiln then in use in England was erected by the de Navarros at the Keystone Portland Cement Company plant, Coplay, Pennsylvania.

YEAR 1891

Year	Barrels	Value	Average Factory Price per Bbl.
1890	335,500	\$704,050	\$2.09
1891	454,813	967,679	2.13

In 1891, the portland cement industry was discussed more in detail in the publications of the United States Geological Survey, for the report of that year was prepared by S. B. Newberry, who continued to edit the cement chapter for some years thereafter. The report in 1891 consisted almost entirely of what must have been considered at the time a very comprehensive survey of the cement industry as a whole. More than half of this contribution was devoted to portland cement, its history, nature of materials, methods of manufacture, testing and general status of the industry at that period.

The states then engaged in manufacture were California, Colorado, one of the Dakotas and Indiana, with one works each; New York, with five; Ohio, with two; and Pennsylvania, with six; a total of seventeen plants.

Companies incorporated in 1891:

Missouri Portland Cement Company, St. Louis. (Originally organized as the Union Sand Company. Began manufacture in 1907. The name was changed to the Missouri Portland Cement Company in 1917.)

YEAR 1892

Year	Barrels	Value	Average Factory Price per Bbl.
1891	454,813	\$ 967,679	\$2.13
1892	547,440	1,152,600	2.11

In 1892, S. B. Newberry gave further emphasis to the growing importance of the portland cement industry, and predicted that within a very few years all of the "artificial" cement used in the country would be produced at home. However, the industry could not be described as unduly prosperous at this time, owing chiefly to high labor costs, but improved machinery was expected to replace much of the costly hand work. Mr. Newberry recommended the rotary kiln as efficient and economical, describing its more important advantages.

For the first time in the history of the industry value of product exceeded a million dollars.

Companies incorporated in 1892:

Sandusky Portland Cement Company, Cleveland, Ohio. (Reorganized in 1916 as the Sandusky Cement Company.)

Diamond Portland Cement Company, Cleveland, Ohio. (Reorganized in 1897.)

YEAR 1893

Year	Barrels	Value	Average Factory Price per Bbl.
1892	547,440	\$1,152,600	\$2.11
1893	590,652	1,158,138	1.91

In spite of unfavorable conditions for growth, the output of portland cement in 1893 showed an increase over the previous year of about 43,000 barrels. With total production hardly exceeding 500,000 barrels, this expansion looked very large to the manufacturers. It was estimated that about 18 per cent of the portland cement used in 1893 was of domestic make and much larger gains were predicted. It was felt that the industry was permanently established. The product had improved in quality as well as quantity. Portland cement and the products made therefrom attracted attention at the Columbian Exhibition, in Chicago, during 1893, and foreign exhibitors were greatly interested in American methods and progress. The trend of comment, however, especially in Germany, would lead to the conviction that the American product was far below foreign standards.—Tests made by S. B. Newberry showed that not only was this not true but that the best of American cements were quite as good as the average of imported cements.

Companies incorporated in 1893:

Glens Falls Portland Cement Company, Glens Falls, New York.

Whitaker Cement Company, Alpha, New Jersey. (Was successor of Thomas D. Whitaker and taken over by Alpha Portland Cement Company in 1895.)

YEAR 1894

Year	Barrels	Value	Average Factory Price per Bbl.
1893	590,652	\$1,158,138	\$1.91
1894	798,757	1,383,473	1.73

Production increased materially in 1894, showing a gain of more than 200,000 barrels over 1893. This increase of 35 per cent was not confined to any particular section. It was partly due to the output of five new mills, the total of works increasing from 19 plants in 1883 to 24 in 1894. Several additional mills were under way. It was observed this year that imports had remained stationary for three years, while domestic production and consumption had rapidly increased. In 1894 nearly one-fourth of the portland cement used was of American make. Other important factors favoring home producers were suspension of the low freight rate from Europe to Chicago and a considerable advance in the price of foreign cement at the expiration of the year. A decided scarcity of portland cement everywhere was reported, and big demands were anticipated. Good American portland cement could be had at from 50 cents to \$1 less than the best German cements, and it was used extensively by the Government.

At this time most of the portland cement produced in the United States was burned in the old-fashioned kilns, but the rotary kiln was growing in favor. In 1893 the product of rotary kilns was 149,000 barrels, which had increased to 242,176 barrels in 1894. The vertical kilns, continuous and intermittent, turned out 441,653 barrels in 1893 and 556,581 barrels in 1894, the figures showing that rotary kiln output was growing much faster than that of the vertical kiln. The use of the Griffin steel mill at the larger plants also occasioned comment, some of the older works still retaining the buhr stones.

Up to 1894 Government reports on the total value of cements included the value of barrels, which was not included thereafter.

Companies incorporated in 1894:

The Vulcanite Portland Cement Company, Philadelphia.

YEAR 1895

Year	Barrels	Value	Average Factory Price per Bbl.
1894	798,757	\$1,383,473	\$1.73
1895	990,324	1,586,830	1.60

Another increase in production took place in 1895, this time amounting to 24 per cent. The increase was confined almost wholly to the larger factories in New York, New Jersey, Pennsylvania and Ohio, several of which doubled the production reported for 1894. It was noted as a matter of importance that two factories near Coplay, Pennsylvania, had again doubled their capacity and were producing over a thousand barrels of cement per day each. Imports had increased over 1894 figures, which was interpreted to mean that American plants had failed to keep pace with the growing demand for portland cement.

Among these early cement records are many prophecies of which the following is typical: "When the industry in this country reaches sufficient magnitude to allow portland cement to be sold at \$1.50 per barrel, there can be little doubt that practically all the natural rock cement now used will be replaced with portland. From present indications, however, it will be many years before this result is even approached."

It was stated at this time that the prejudice once existing against domestic portland cement had almost entirely disappeared and that careful study of tests would show that no cement of foreign make was superior to the best American brands.

Companies incorporated in 1895:

Alpha Portland Cement Company, Easton, Pennsylvania. (Was successor of the Whitaker Cement Company, which incorporated in 1893, taking over the Thomas D. Whitaker plant.)

YEAR 1896

Year	Barrels	Value	Average Factory Price per Bbl.
1895	990,324	\$1,586,830	\$1.60
1896	1,543,023	2,424,011	1.57

Production of portland cement in 1896 increased nearly 56 per cent over 1895 figures, and for the first time output, as officially recorded, reached the 1,000,000 mark, the total being a little over 1,500,000 barrels, which was regarded as extraordinary. There was reason to believe, however, that complete records for the previous year would have placed output a little in excess of 1,000,000 barrels. The increase during 1896 took place in all important producing districts, but was most marked in the Lehigh district and Phillipsburg, New Jersey. The capacity of plants in these localities had been increased materially with quality of cement practically as good as that produced in Germany and England. In 1896, 26 works were in operation in Pennsylvania, New York, New Jersey, Ohio, California, South Dakota, Illinois, Indiana, Michigan, Texas and Utah. These states had one plant each with the exception of New York, New Jersey, Ohio and Pennsylvania, which had seven, two, four and seven,

respectively. The mills in Pennsylvania and New Jersey were producing much more than half of the country's total output, and increase in the development of the industry was more rapid there than elsewhere, this being due to abundant and suitable materials and good shipping facilities. Of the 26 mills, 18 were using limestone and the rest marl.

Import figures for 1895-96 showed comparatively small, but increasing, shipments from Canadian mills at Owen Sound and Napanee, Ontario, the cement coming into Detroit.

YEAR 1897

Year	Barrels	Value	Average Factory Price per Bbl.
1896	1,543,023	\$2,424,011	\$1.57
1897	2,677,775	4,315,891	1.61

Another increase, considered as most remarkable, was recorded in 1897, production running considerably beyond an excess of the previous year's output, a gain of nearly 74 per cent. In the main producing centers production was almost doubled, which was also the case with the total value of the entire output for the year. The total imports for 1897 amounted to 2,090,024 barrels, which was less than production of portland cement in the United States, a more than complete reversal of the situation in 1896. Production in the Lehigh district in 1897 was ten times greater than in 1890.

Decrease in imports was attributed to increasing foreign demand and less activity on the part of the exporting companies who had sought to control the American markets.

That American manufacturers were doing their best to merit the confidence of consumers is shown by the following extract from S. B. Newberry's report for 1897:

Considerably more than half the portland cement consumed in 1897 was of American manufacture. This important step toward the replacement of imported by domestic portland has been largely brought about by the successful efforts of American manufacturers to produce a high-grade product. Engineers in all parts of the country are finding, to their surprise, that the product of the leading American factories shows decidedly higher tests than the imported brands which have long been regarded as standard. This is strikingly shown in the reports of Richard L. Humphrey, Inspector of Cements for the City of Philadelphia. The average of all American portlands tested in 1896 and 1897 is decidedly higher, both neat and with sand, than that of all the English or German portlands tested. In fineness of grinding also the American cements were found superior to the imported. It is gratifying to find that an industry so new in this country, and one requiring so high a degree of technical knowledge, has already been developed to a point beyond that which it has reached in England and Germany.

An important factor in the situation in 1897, as it concerned consumption of cement, was its use in fortifications and other Government works growing out of impending war with Spain. The Government for a

time purchased thousands of barrels per day, and building enterprises were active generally. The two largest factories, in Pennsylvania and New Jersey, had increased their capacity by 50 per cent, while provisions for increased capacity were in progress at other works.

Companies incorporated in 1897:

Lehigh Portland Cement Company, Allentown, Pennsylvania.

Castalia Portland Cement Company, Castalia, Ohio.

YEAR 1898

Year	Barrels	Value	Average Factory Price per Bbl.
1897	2,677,775	\$4,315,891	\$1.61
1898	3,692,284	5,970,773	1.62

Predictions as to increased output for 1898 were fully verified, and another advance of more than a million barrels took place, amounting to 37.9 per cent over 1897 production. The total for 1898 was 3,692,284 barrels. The number of works had increased from 16 in 1890 to 31 in 1898. The Lehigh district was more than holding its own, producing nearly three-fourths of the total product of the country. Production in New York and Ohio showed an increase, but in other sections of the country development of the industry was slow.

Interesting announcements for the year included a statement that the Illinois Steel Company, Chicago, one of the largest manufacturers of slag cement, had practically abandoned this industry and proposed to make a true portland cement by grinding blast-furnace slag with the necessary proportion of limestone, and burning the mixture in rotary kilns. The plants using limestone had increased from 18 in 1897 to 20 in 1898, with no change in the number using marl, the latter numbering 11 plants. This was the day of prophecy, and it was predicted that 1899 would show a large increase in the production of portland cement and that 1900 would also be a record-breaker.

Companies incorporated in 1898:

Peerless Portland Cement Company, Union City, Michigan.

Chicago Portland Cement Company, Chicago. (Acquired by Lehigh Portland Cement Company, December 16, 1916.)

Helderberg Cement Company, Howes Cave, New York.

Lawrence Portland Cement Company, Siegfried, Pennsylvania.

YEAR 1899

Year	Barrels	Value	Average Factory Price per Bbl.
1898	3,692,284	\$5,970,773	\$1.62
1899	5,652,266	8,074,371	1.43

An increase of nearly 2,000,000 barrels occurred in 1899, a gain of about 53 per cent over 1898. Knowing that new mills were projected and that the capacity of others had been increased, manufacturers were looking for a marked expansion in production. In 1899 there were 36 works, as against 31 the previous year. In the matter of output in 1899, Pennsylvania led with 3,217,965 barrels, New Jersey came second with 892,167 barrels, Ohio third with 480,982 barrels, and New York fourth with 472,386 barrels, other states falling far below these figures. Changes had taken place in production by states within a single year. In 1898 New York's seven mills produced 554,358 barrels, which dropped to 472,386 in 1899, with no change in the number of works. In 1898 Ohio produced 265,872 barrels, which increased to nearly a half million barrels the following year, her works numbering six plants both years. The drop in New York production was attributed to continued use of vertical kilns. Michigan attracted attention in 1899 with an output of 342,566 barrels from four plants. She had produced only 77,000 barrels, from two mills, the preceding year.

Importations showed a surprising increase for the year, which was attributed to great activity in building circles, thus increasing the demand for foreign makes on the part of masons of foreign birth and a few engineers who still cherished the delusion that foreign cement, costing a dollar a barrel more than American brands, was a good investment.

For the first time in the history of the industry, concern was manifested lest the country was exceeding safe limits in building so many cement works. It was feared that over-production and disaster to smaller and unfavorably situated concerns might result from further expansion, and very keen competition was believed to be almost at hand. Attention was called to the fact that the average rate of increase from year to year had been about 40 per cent and that if continued four years more production would exceed 20,000,000 barrels, more than Germany's output at that time. But in spite of this many new projects were under way, with the capacity of existing mills constantly increasing. Enthusiasm was tempered, however, by the growing conviction that only the owners of large and favorably situated deposits and mills with large daily capacity could hope for profitable results.

Among the 1899 announcements calculated to create a sensation was one to the effect that the Edison Company of New Jersey, "proposes to burn cement in a gigantic rotary kiln 110 feet in length and 10 feet in diameter."

Companies incorporated in 1899:

Atlas Portland Cement Company, New York City.

Peninsular Portland Cement Company, Cement City, Michigan.

Phoenix Portland Cement Company, Philadelphia.

Omega Portland Cement Company, Jonesville, Michigan. (Manufacture suspended in 1914.)

Wabash Portland Cement Company, Detroit, Michigan.

Newaygo Portland Cement Company, Newaygo, Michigan.

The Edison Portland Cement Company, West Orange, New Jersey.

Dexter Portland Cement Company, Nazareth, Pennsylvania.

YEAR 1900

Year	Barrels	Value	Average Factory Price per Bbl.
1899	5,652,266	\$8,074,371	\$1.43
1900	8,482,020	9,280,525	1.09

Nearly 3,000,000 barrels, a fraction over 50 per cent, was the increase of 1900 compared with 1899. Pennsylvania and New Jersey maintained their prestige as the great producing centers. Illinois jumped from 53,000 barrels to nearly 500,000 barrels, with only one new mill added to the two in operation the previous year. Michigan almost doubled her output, her resources increasing from four to six plants. A total of 50 works was reported in 1900, as against 36 in 1899. Output had increased in Colorado, Indiana and Texas; and Kansas and Virginia made their first appearance on the cement map. Ohio was falling behind, not as to increase, but percentage of total, which was attributed to a lack of large sources of suitable raw material. Michigan was regarded as a cement state of great promise. Of her progress it was said: "There are at present nine factories in operation in the state and five more under construction while an almost countless number are projected. Marl is abundant everywhere and nearly every lake and marsh in the state is underlain by it."

Such marked expansion took place in Indiana, Illinois, Kansas, Virginia, Texas and the West that it was announced they would no longer appear in Government tables under the grouping of "Other Sections," but would require subdivisions.

Foreign manufacturers gave their American competitors another surprise by increasing exports nearly 280,000 barrels, the figures from 1897 showing totals of over 2,000,000 barrels each year. Extraordinary demand for cement was given as the reason for increased imports in 1900. Incidentally, the total production of European portland cement at the time was estimated at about 44,000,000 barrels, as against America's 8,500,000 barrels.

Companies incorporated in 1900:

Pennsylvania Cement Company, New York City.

Detroit Portland Cement Company, Detroit, Michigan. (Now Aetna Portland Cement Company.)

Alsen's American Portland Cement Works, New York City. (Succeeded in 1919 by the Alsen Cement Company of America, Inc., New York City.

YEAR 1901

Year	Barrels	Value	Average Factory Price per Bbl.
1900	8,482,020	\$ 9,280,525	\$1.09
1901	12,711,225	12,532,360	.99

Production in 1901 showed another 50 per cent increase, total production reaching nearly 13,000,000 barrels, thus verifying the predictions of the preceding year. Works had increased from 50 to 56. The states in which plants had been established were as follows:

State	No. Plants	State	No. Plants
Arkansas.....	1	North Dakota.....	1
California.....	1	Ohio.....	7
Colorado.....	1	Pennsylvania.....	13
Illinois.....	4	South Dakota.....	1
Indiana.....	2	Texas.....	2
Kansas.....	1	Utah.....	1
Michigan.....	10	Virginia.....	1
New Jersey.....	3		
New York.....	7	Total	56

How production was apportioned among the various districts as established at that time is shown in the following table:

PORTLAND CEMENT PRODUCED BY DISTRICTS IN 1901

District	No. of Works	Barrels	Percentage of Total Production
New York.....	7	617,228	4.8
Lehigh and Northampton Counties, Pa., and Warren County, N. J.....	16	8,595,340	67.7
Ohio.....	7	689,852	5.4
Michigan.....	10	1,025,718	8.0
All Other Sections.....	16	1,783,087	14.1
Totals.....	56	12,711,225	100.0

"All other Sections" included California, Colorado, Illinois, Indiana, Kansas, South Dakota, Texas and Utah, Virginia being tabulated with Ohio.

At this time the efficiency and economy of the rotary kiln had become fully recognized and while vertical kilns were still in use they were fast

becoming an obsolete proposition insofar as the manufacture of portland cement was concerned. Announcement of the building of new works showed that the capacity of the country would be largely increased the following year. The total consumption of portland cement in the United States in 1901 was estimated at 13,216,026 barrels, imports having dropped from about 2,225,000 barrels in 1900 to a little under 1,000,000 barrels in 1901.

Companies incorporated in 1901:

Alabama Portland Cement Company, Demopolis, Alabama. (Taken over by Gulf States Portland Cement Company.)

Ironton Portland Cement Company, Ironton, Ohio.

Colorado Portland Cement Company, Portland, Colorado.

Pacific Portland Cement Company, San Francisco, California. (Re-organized as the Pacific Portland Cement Company, Consolidated, in 1905.)

YEAR 1902

Year	Barrels	Value	Average Factory Price per Bbl.
1901	12,711,225	\$12,532,360	\$0.99
1902	17,230,644	20,864,078	1.21

Fully 4,500,000 barrels was the increase in portland cement production for 1902, as compared with 1901, the total running over 17,000,000 barrels. The status of portland and competing cements in 1902 was as follows:

Cement	Barrels
Portland	17,230,644
Natural	8,044,305
Puzzolan	478,555
Imported	1,963,023

Enthusiasm over increased production of portland cement was tempered somewhat by a marked decline in prices throughout the eastern states, but depression was temporary. That optimism still prevailed was shown by the building of new works, enlargement of existing plants and increasing demand for cement. The number of works had increased to 65 in 1902, as against 56 in 1901, the increase in plants taking place in Alabama, California, Colorado, Indiana, New York and Pennsylvania; New York showing an increase of three works, Pennsylvania two, and the other states one each. Three new states entered the field that year: Alabama, Georgia and Missouri. The one plant credited to New Mexico in previous years suspended operation and the state was dropped from the records. Pennsylvania and New Jersey still occupied the first and second places, respectively, in percentage of total output.

Increased production through the adoption of rotary kilns was attracting more than ordinary attention, and in 1902 the status of vertical and rotary kilns was as follows:

PORTLAND CEMENT KILNS IN 1902

Kind	Active	Idle	Building
Vertical	611	76	6
Rotary.....	456	9	46
Total.....	1067	85	52

It was estimated that portland cement burned in vertical kilns in 1902 would not exceed 1,500,000 barrels, out of the total production of over 17,000,000 barrels.

Companies incorporated in 1902:

Penn-Allen Portland Cement Company, Allentown, Pennsylvania.
(Reorganized as Penn-Allen Cement Company in 1910.)

Wolverine Portland Cement Company, Coldwater, Michigan.

Southern States Portland Cement Company, Rockmart, Georgia.

YEAR 1903

Year	Barrels	Value	Average Factory Price per Bbl.
1902	17,230,644	\$20,864,078	\$1.21
1903	22,342,973	27,713,319	1.24

The mere increase in production in 1903 as compared with output in 1902, exceeded by more than one-half the total production of only three years back, as production in 1900 amounted to about 8,500,000 barrels. The increase in 1903 was 5,112,329 barrels. The result was an overstocked market, and prices of portland cement went so low as to bring it into serious competition with natural cement. Owing to this situation some of the natural cement plants were closed during the year. The natural cement output for 1903 was a little over 7,000,000 barrels, portland cement production exceeding it three to one. Pennsylvania continued in the lead with 17 plants and an output of nearly 10,000,000 barrels. New Jersey ranked second and Michigan third, the former having three works producing nearly 3,000,000 barrels, and the latter 13 plants producing close to 2,000,000 barrels. New York had fourth place with 12 works producing over 1,500,000 barrels. Nineteen states contributed to the total output in 1903, some plants producing both natural and portland cements. A detailed description of production by states refers to a plant at Spocari, near Demopolis, Alabama. The development of the Kansas field was attracting attention at the time, especially the opportunity to use natural gas for fuel.

Companies incorporated in 1903:

Huron & Wyandotte Portland Cement Companies, Detroit, Michigan.

YEAR 1904

Year	Barrels	Value	Average Factory Price per Bbl.
1903	22,342,973	\$27,713,319	\$1.24
1904	26,505,881	23,355,119	.88

That matters were not in desirable shape in 1904 is disclosed by the figures on production and value. While production exceeded that of the previous year by a little over 4,000,000 barrels, the total value was less than for the preceding year, there being a difference of about \$4,350,000 in favor of 1903. Price cutting had exceeded anything witnessed theretofore, some of the Lehigh mills selling cement below cost of production. There was further reduction in the output of natural cement.

The drift of affairs in the latter industry was disclosed by the fact that in 1904 Pennsylvania, one of the big centers of the industry, had no mills making natural cement exclusively. All of the Pennsylvania natural cement came from five works having an output of both portland and natural rock cements. The state had at that time 17 portland cement plants.

Concerning the different raw materials used at this period, factories and output were divided as follows:

Material Used	No. of Companies	Production, Bbls.
Limestone and cement rock.....	21	13,902,939
Limestone and shale.....	18	5,631,686
Marl and clay.....	17	3,332,873
Limestone and clay.....	17	3,141,010
Limestone and slag.....	3	497,373
Chalk and clay.....	2	Idle
	78	26,505,881

Five mills, either new or inoperative, were not included in this number.

Companies incorporated in 1904:

Bath Portland Cement Company, Bath, Pennsylvania.

Kosmos Portland Cement Company, Inc., Kosmosdale, Kentucky.

Burt Portland Cement Company, Bellevue, Michigan. (Acquired by Alpha Portland Cement Company, 1920.)

YEAR 1905

Year	Barrels	Value	Average Factory Price per Bbl.
1904	26,505,881	\$23,355,119	\$0.88
1905	35,246,813	33,245,867	.94

Both production and value of portland cement leaped ahead in 1905, which proved to be a record-breaking year in increased output, the latter amounting to nearly 9,000,000 barrels. Better still, production hardly kept pace with demand, and it was announced that American cements had finally been successful in displacing imported cements. There developed at this time a demand for white portland cement for interior finishing and decorative purposes, and it was predicted that ere long some of the limestone deposits free from iron would be utilized for this purpose. The production of all cements in 1905 was as follows:

Portland cement	35,246,812 barrels
Natural “	4,473,049 “
Puzzolan “	382,447 “

A change took place in the order of states, Indiana displacing Michigan as third in volume of production, the latter dropping to fourth place. Companies incorporated in 1905:

Hecla Portland Cement Company, Bay City, Michigan. (Dissolved in 1915, and plant subsequently dismantled.)

Pacific Portland Cement Company, Consolidated, San Francisco, California. (Formerly the Pacific Portland Cement Company.)

Santa Cruz Portland Cement Company, San Francisco, California.

YEAR 1906

Year	Barrels	Value	Average Factory Price per Bbl.
1905	35,246,812	\$33,245,867	\$0.94
1906	46,463,424	52,466,186	1.13

With 1906 production showing another big increase and prices higher but not inflated, portland cement manufacturers had nothing to complain of except shortage of car service. The increase in production exceeded 11,000,000 barrels, but the industry was on a healthy and normal basis.

In 1906, there were 793 rotary kilns in operation, 2 idle and 104 under construction. The length of about half of the kilns in operation was 60 feet or less. There were 80 kilns of 105 to 110 feet and 57 kilns 125 feet long or longer.

It was noted by Eckel that “at present (1906) the cement industry is the most individualistic of the larger branches of manufacture,” and that “no trust nor even any approach to a monopoly is now in existence, newspaper statements to the contrary notwithstanding.”

The foregoing reveals the fact that the industry had reached such magnitude as to attract attention as an industrial factor of national importance.

The total authorized capitalization of all the American portland cement plants operating in 1906 was placed between \$110,000,000 and

\$125,000,000. There had been little attempt at over-capitalization in the industry, and promotions of questionable character were confined chiefly to Michigan, Kansas and Iowa.

Companies incorporated in 1906:

Dewey Portland Cement Company, Dewey, Oklahoma.

Union Portland Cement Company, Ogden, Utah.

The United States Portland Cement Company, Denver, Colorado.

Universal Portland Cement Company, Chicago. (Operated as Cement Department of the Illinois Steel Company until October 1, 1906, when the present company was organized as a subsidiary of the United States Steel Corporation.)

Dixie Portland Cement Company, Chattanooga, Tennessee.

Golden State Portland Cement Company, Los Angeles, California.

Oklahoma Portland Cement Company, Ada, Oklahoma.

Superior Portland Cement Company, Seattle, Washington.

YEAR 1907

Year	Barrels	Value	Average Factory Price per Bbl.
1906	46,463,424	\$52,466,186	\$1.13
1907	48,785,390	53,992,551	1.11

Output in 1907 increased 2,321,966 barrels compared with 1906. The leading states that year were Pennsylvania, New Jersey, Indiana, Michigan and Kansas, which ranked in the order given. All of the remaining states produced less than 13,000,000 barrels, the five states named producing almost three-quarters of the total output of the country.

Like the iron industry, which had centered around Pittsburgh, the portland cement industry first concentrated in the Lehigh district and in New Jersey. The geographical distribution of the industry in 1907 is shown in the following table:

GEOGRAPHICAL DISTRIBUTION OF PORTLAND CEMENT INDUSTRY IN 1907

	Barrels	Percentage of Output
East.....	27,134,816	55.6
Central.....	13,479,703	27.6
West.....	4,463,397	9.2
Pacific Coast.....	1,893,004	3.9
South.....	1,814,470	3.7
Total.....	48,785,390	100.0

The 1907 United States Geological Survey report discusses concentration of interests in the cement industry, giving three factors calculated to

make for control, these being the normal growth of profitable plants, consolidation by stock control, and the growth of the patent holding company.

The well-located and well-managed plants had opportunity for expansion which was denied to plants of less technical or financial soundness.

Stock control as distinguished from direct ownership was illustrated in the case of the Iola or Nicholson group, with seven plants, mostly in the Kansas district; the W. J. Dingee group in California, Washington and Pennsylvania, and the Cowham plants in Michigan, Iowa, Kansas and Texas. There were also smaller or "community of interests" examples.

In 1906, a great patent-holding corporation, The North American Portland Cement Company, was organized with a capital of \$10,000,000, its purpose and operation being described in detail elsewhere.

Companies incorporated during 1907:

Allentown Portland Cement Company, Allentown, Pennsylvania.

Ash Grove Lime and Portland Cement Company, Kansas City, Missouri.

Cape Girardeau Portland Cement Company, Cape Girardeau, Missouri.

Riverside Portland Cement Company, Los Angeles, California.

Southwestern Portland Cement Company, El Paso, Texas.

Trinity Portland Cement Company, Dallas, Texas. (Organized as Southwestern States Portland Cement Company in 1907.)

Continental Portland Cement Company, St. Louis, Missouri.

The manufacture of portland cement by the Louisville Cement Company began this year. The company was incorporated in 1866 to manufacture natural cement.

Three Forks Portland Cement Company, Denver, Colorado.

Missouri Portland Cement Company began manufacture this year. (This company was originally the Union Sand Company, organized in 1891. Name was changed to Missouri Portland Cement Company, with headquarters at St. Louis, Missouri, in 1917.)

Maryland Portland Cement Company, Baltimore, Maryland. (This company was consolidated with the Berkeley Limestone Company, Berkeley, West Virginia, and in 1909 became the Security Cement and Lime Company, Baltimore, Maryland.)

YEAR 1908

Year	Barrels	Value	Average Factory Price per Bbl.
1907	48,785,390	\$53,992,551	\$1.11
1908	51,072,612	43,547,679	.85

A small increase, 4.6 per cent, in production and a decline of 19.3 per cent in value was the record of 1908 as compared with 1907. Production

increased 2,287,222 barrels. Trade conditions had been such that a decrease in production, rather than an increase, would have been the logical thing to expect. The only thing that saved the day was increased output by the United States Steel Corporation, which amounted to 2,405,600 barrels, which was more than the increase in total production. All of the older producing states, especially in the East, showed a heavy decrease in output.

The fact that New York had dropped to eighth place among producing states occasioned considerable comment. An analysis of the situation resulted in the conclusion on the part of Government experts that the manufacture of a large quantity of cement rather than the earning of dividends had governed the selection of plant sites up to date, and that with plants established at strategic points from the shipping and selling point of view the state could find a market for large output. There were about four such favored locations.

Companies incorporated in 1908:

Knickerbocker Portland Cement Company, New York City. (Reorganized in 1918.)

San Antonio Portland Cement Company, San Antonio, Texas.

Iowa Portland Cement Company, Des Moines, Iowa. (Succeeded by Hawkeye Portland Cement Company in 1916.)

YEAR 1909

Year	Barrels	Value	Average Factory Price per Bbl.
1908	51,072,612	\$43,547,679	\$0.85
1909	64,991,431	52,858,354	.813

Nearly 14,000,000 barrels increase was recorded for 1909. This was 27.2 per cent increase in quantity, which was accompanied by 21.3 per cent increase in value. Concerning the status of the industry, it was said that annual output might be expected to increase as population increased and new uses were found for cement, but that future increase could hardly be expected to maintain the steady advance shown in the past. Competition had become very keen but a broad cooperative policy had been adopted by the officials of some 22 large portland cement companies and other interested parties who realized that whatever benefited the industry at large must benefit the individual producer. Cooperative advertising, instruction and exhibitions of cement products were producing good results.

Companies incorporated in 1909:

Bonner Portland Cement Company, Bonner Springs, Kansas.

Tidewater Portland Cement Company, Baltimore, Maryland.

Security Cement and Lime Company, Hagerstown, Maryland. (Originally the Maryland Portland Cement Company, organized in 1907.)

Canada Cement Company, Ltd., Montreal, Canada.

YEAR 1910

Year	Barrels	Value	Average Factory Price per Bbl.
1909	64,991,431	\$52,858,354	\$0.813
1910	76,549,951	68,205,800	.891

In 1910, the industry made a new high record, production surprising even manufacturers by running a little more than 1,500,000 barrels in excess of the highest estimates, which had been placed at about 75,000,000 barrels. At the time, 25 states were producing portland cement from a total of 111 plants. The average factory price per barrel in 1910 was 89.1 cents. The fluctuation in number of plants throughout the few preceding years had been as follows:

District	Plants in Operation			
	1907	1908	1909	1910
East.....	34	28	35	36
Central.....	37	40	36	33
West.....	10	13	17	18
Pacific Coast.....	5	6	8	9
South.....	8	11	12	15
Total.....	94	98	108	111

The year 1910 was an important one. While prices were far from satisfactory, especially in the East, it was in 1910 that the real importance of the portland cement industry received proper emphasis. In an address delivered before the cement manufacturers in December of that year, Edwin C. Eckel, the well-known geologist and Government expert, called attention to the fact that the amount of capital employed in the cement industry, which was then almost \$150,000,000, far exceeded the capital invested in the plants producing gold, and surpassed even copper, ranking next to iron and coal among American industries. On the basis of capital actually employed, pig iron represented somewhat over \$300,000,000, while the value of all copper mining and smelting plants was about \$110,000,000. In brief, the cement industry had reached a point that made it a matter of importance not only to cement manufacturers but to commercial and financial interests generally. From a banking point of view, the cement industry had become, to quote Mr. Eckel, "one of the world's three great extractive industries."

Companies incorporated in 1910:

The Olympic Portland Cement Company, Ltd., Seattle, Washington.

Clinchfield Portland Cement Corporation, Kingsport, Tennessee.

The Ogden Portland Cement Company, Ogden, Utah.

International Portland Cement Company, Ltd., Spokane, Washington.

YEAR 1911

Year	Barrels	Value	Average Factory Price per Bbl.
1910	76,549,951	\$68,205,800	\$0.891
1911	78,528,637	66,248,817	.844

The year 1911 closed with the portland cement manufacturers in anything but a cheerful frame of mind. While production showed an increase of 2.58 per cent, the value of cement decreased 2.87 per cent. This was ascribed in part to the building of new plants in 1908 and 1909 and the substitution in many plants of long kilns for the shorter lengths, all of which increased output. The average factory price per barrel was 84.4 cents. During the year nine new plants reported their first commercial output, these being in California, Georgia, Iowa, Kansas, Maryland, Michigan, New York, Tennessee and Washington. It was in 1911 that attention was directed to another change in the general situation. In earlier years shipments had been made into far distant fields, the consumer having to pay freight. With the establishment of mills throughout territory formerly dependent on more distant plants, the latter found freight charges a serious obstacle. Where freight charges did not differ materially as between cement shipped from old and new mills, competition resulting in cross shipments began. This latter practice became, throughout succeeding years, decidedly disadvantageous to a great many companies as a large number adopted the plan of unloading surplus cement in territory logically the domain of competing companies, the result being ruinous prices. In the latter part of 1911 many large Eastern contracts made at 75 to 85 cents a barrel expired, and new ones were made as low as 60 to 65 cents.

Companies incorporated in 1911:

Michigan Portland Cement Company, Chelsea, Michigan. (A plant with 12 vertical kilns was constructed about 1903 by Homer C. Millen, son of Thomas Millen, at the site of the Michigan Portland Cement Company's works, but the enterprise was not successful, and the plant was taken down to make room for the plant of the Michigan Company.)

YEAR 1912

Year	Barrels	Value	Average Factory Price per Bbl.
1911	78,528,637	\$66,248,817	\$0.844
1912	82,438,096	67,016,928	.813

In spite of the conditions prevailing in 1911, reports for 1912 showed another increase of approximately 4,000,000 barrels, with virtually no change in the number of active plants. The average price per barrel was 81.3 cents compared with 84.4 cents in 1911. The lowest prices were reported from the Lehigh district. At this time six plants were producing white portland cement amounting to over a half million barrels, which was valued at \$2.29 a barrel, these mills being located in California, Colorado, Indiana and Pennsylvania. In 1912 at least 45 of the active plants were idle during three months or more, the majority having shut down on account of full stock houses and lack of demand for cement. In Alabama, Kansas, Pennsylvania, Texas and Virginia some mills went into the hands of receivers.

Comparatively new uses for cement attracting special interest at the time included construction of concrete roads and a growing demand for cement in architectural and art work.

Extension of the portland cement industry at the time was confined chiefly to the Pacific coast.

YEAR 1913

Year	Barrels	Value	Average Factory Price per Bbl.
1912	82,438,096	\$67,016,928	\$0.813
1913	92,097,131	92,557,617	1.005

The year 1913 was marked by another surprising increase in production, which amounted to 11.7 per cent as compared with 1912. The output jumped from about 82,400,000 barrels in 1912 to a little over 92,000,000 barrels, making 1913 the year in which the third largest annual output in the history of the industry took place. The exact figures for 1913 were 92,097,131 barrels, the second largest output being 1917, with 92,814,202 barrels, and the third in 1920 with 100,023,245 barrels. The average factory price per barrel in 1913 was \$1.005. Increased consumption of cement took place, due in a large measure to increased demand for farm purposes and the construction of concrete roads. The concrete roads in Wayne County, Michigan, were attracting national attention and other states were preparing to construct extended mileage. The use of cement for this purpose was recognized by manufacturers as a matter of vital importance. An increase of nearly 20 cents a barrel over 1912 was an encouraging circumstance, particularly after the situation prevailing during the three or four preceding years, when many companies became insolvent or bankrupt.

A careful analysis of previous conditions showed that matters could be improved by more careful cost accounting, particularly with reference to depreciation and obsolescence, two important factors receiving little

attention up to that period. Altogether, 1913 was considered a good year in the industry. From the standpoint of production by districts, marked changes were taking place, output from the Lehigh district, which had long been the great manufacturing center, dropping to 30 per cent of the total output of 1913, while increases took place in New York, Illinois, Northwestern and Indiana district, the Iowa and Missouri district and the Pacific Coast district.

Companies incorporated in 1913:

Giant Portland Cement Company, Philadelphia. (Originally the American Cement Company, the latter successor of the American Improved Cements Company.)

Monarch Cement Company, Humboldt, Kansas. (Reorganized above year.)

The Great Western Portland Cement Company of Kansas, Kansas City, Missouri.

YEAR 1914

Year	Barrels	Value	Average Factory Price per Bbl.
1913	92,097,131	\$92,557,617	\$1.005
1914	88,230,170	\$1,789,368	.927

Before the close of 1914, portland cement manufacturers found that their industry, in common with other American industries, had become subject to influences originating far beyond the boundaries of the United States. The European war resulted in a decrease in production, the first decline since the manufacture of portland cement began in America. From a fraction over a dollar a barrel at the mills in 1913, the average price declined to 92.7 cents. About 65 per cent of the mills were affected adversely as to prices, 23 per cent receiving practically the 1913 prices, and 12 per cent being fortunate enough to receive higher prices than 1913. In the East, markets approached a state of demoralization with symptoms of a price war. Uncertainty as to the duration and outcome of the World War caused cessation of many construction projects.

Companies organized in 1914:

Texas Portland Cement Company, Dallas, Texas.

YEAR 1915

Year	Barrels	Value	Average Factory Price per Bbl.
1914	88,230,170	\$81,789,368	\$0.927
1915	85,914,907	73,886,820	.860

The trade war presaged by conditions in 1914 began in 1915, when prices declined, dropping to an average factory price of 86 cents per barrel

as against 92.7 cents the previous year. There was little change in production as compared with 1914, the increase being only 0.5 per cent. Building operations were still restricted and the year opened with limited demand for cement. Several months later the situation improved somewhat, but price cutting became abnormal, even in the face of advancing prices for coal and labor at the mills. Toward the close of the year, however, conditions became more stable and prices began to advance in accordance with increased demands for cement.

Companies incorporated in 1915:

Oregon Portland Cement Company, Portland, Oregon.

YEAR 1916

Year	Barrels	Value	Average Factory Price per Bbl.
1915	85,914,907	\$ 77,886,820	\$0.860
1916	91,521,198	100,947,881	1.103

Increased shipments and gradual advance in the price of cement were the outstanding features of 1916. Dollar cement returned and continued to advance, the average price at the mills being \$1.103 per barrel. Shipments decreased the stocks on hand 27.1 per cent. Building materials of all descriptions advanced in price, most of them increasing more rapidly than cement. The year also witnessed a reversal of consumption statistics as applied to some districts. In 1916 the eastern states took 39.69 per cent of the total output and the mid-western states 37.61 per cent. In 1913 exactly the opposite was true. The Lehigh district, which had reached a maximum of 74.8 per cent of the total output of the country in previous years, dropped to a fraction over 24 per cent in 1916. Another trend in the industry noted in 1916 was the purchase of plants by large companies as distinguished from the building of new mills. This increased the distribution geographically of a single brand, thus making the operations of some of these companies national in scope, by which the consumer profited through reduced freight charges and lower cost of production.

Companies incorporated in 1916:

Hercules Cement Corporation, Hercules, Pennsylvania. (Construction of this plant was undertaken originally by the Atlantic Portland Cement Company, of which Irving Bachman and W. Dingee were the principals. It was intended to be one of their chain of plants operating or under construction prior to 1910.)

The Wellston Iron Furnace Company, Jackson, Ohio.

Hawkeye Portland Cement Company, Des Moines, Iowa. (Succeeded the Iowa Portland Cement Company.)

YEAR 1917

Year	Barrels	Value	Average Factory Price per Bbl.
1916	91,521,198	\$100,947,881	\$1.103
1917	92,814,202	125,670,430	1.354

In 1917, production of portland cement exceeded all previous records, output reaching approximately 93,000,000 barrels. There occurred, however, a slight decrease in shipments as compared with 1916. The average price at the factories increased to \$1.354 per barrel as against \$1.103 in 1916, the advance being due to war conditions. Three new plants reported production, these being in Pennsylvania, Iowa and Oregon.

A matter of moment brought up in 1917 was a change in the specification for fineness of portland cement from 75 per cent to 78 per cent on a 200-mesh sieve, which involved installation of the machinery required to meet the change. It had been the purpose of the Government to demand 80 per cent fineness by July 1, 1918, but this was waived until after the war.

During the year, manufacturers became especially interested in a new phase of concrete construction, the building of concrete ships to meet war emergencies, which, it was hoped, would become a standardized industry. The destruction of important highways under war traffic also promised increased demand for cement for road purposes, many of the lighter types of roads having failed under the test of heavy truck traffic. The year also marked the installation of potash-recovery plants at a number of mills.

Incidentally, there was conspicuous decline in the production of puzzolan and natural cements. The natural cement output decreased some 200,000 barrels, while puzzolan production was restricted to a point virtually amounting to cessation of the industry. As a matter of history, it may be said that the first recorded output of puzzolan occurred in 1895, when 12,000 barrels were produced. In 1907 output reached something over 500,000 barrels, declining to about 43,000 barrels in 1915.

Companies incorporated in 1917:

Indiana Portland Cement Company, Greencastle, Indiana.

Nebraska Cement Company, Superior, Nebraska.

YEAR 1918

Year	Barrels	Value	Average Factory Price per Bbl.
1917	92,814,202	\$125,670,430	\$1.354
1918	71,081,663	113,730,661	1.598

In 1918, war conditions resulted in marked decline in production, which fell below the annual output of all preceding years back to and

including 1910. The greatest decline in production took place in the far western and Pacific coast districts. The Government took control of the industry insofar as it concerned distribution of cement, and indirectly exercised partial control of the manufacturing side of the industry through its power to restrict the use of fuel and railway shipments. About 54 per cent of the country's total mill capacity was utilized. The largest consumption took place in localities requiring important Government work. Interest in concrete ships increased, contracts for 42 vessels having been let by the Emergency Fleet Corporation. The average factory prices of cement per barrel advanced from \$1.354 in 1917 to \$1.596 in 1918, the highest prices prevailing in the east. Advanced price, however, was largely offset by increase in the cost of labor and materials. The Government and cement manufacturers cooperated in seeking to introduce economies in manufacturing, especially with relation to fuel.

During the year two new plants, one in California and the other in Montana, commenced manufacturing. Six of the 114 plants throughout the country were idle.

Importations of cement were practically wiped out, only 305 barrels coming in during 1918.

YEAR 1919

Year	Barrels	Value	Average Factory Price per Bbl.
1918	71,081,663	\$113,730,661	\$1.598
1919	80,777,935	138,130,269	1.71

With coal and car requirements still subject to war restraints, the winter conditions of 1919 were extremely dull, but in the spring building activities revived, creating a demand for cement which resulted, during the last six months of the year, in the largest shipments in six months ever known in the history of the industry. Taking the entire year, there was an increase of 13 per cent in production and 21 per cent in shipments over 1918. Production in 1919 amounted to 80,287,000 barrels, as against 71,081,663 in 1918.

Comparison of the market prices of portland cement with those of other industries, especially in the building trades, indicate that cement did not advance proportionately with other commodities, and that in the face of car shortages, higher prices for fuel and increased labor costs the total advance was slight as compared with the previous year. The records of 1919 show that consumption had gone back to its pre-war per capita consumption of 0.78 barrel.

There were 111 plants producing cement in 1919, with shipments from 113 plants. The estimated total capacity of the country was 130,-

000,000 barrels per year, while the highest annual production ever recorded was a little under 93,000,000 barrels.

With the close of the war the various Governmental restrictions on the industry, which affected prices, fuel and car supply, were gradually removed.

Companies incorporated in 1919:

The British Columbia Cement Company, Ltd., Victoria, B. C.

The Alsen Cement Company of America, Inc., New York City. (Successor of Alsen's American Portland Cement Works, incorporated in 1900.)

International Cement Corporation, New York City.

LaSalle Cement Company, Chicago, Illinois. (Successor of German-American Portland Cement Works.)

St. Mary's Cement Company, Ltd., Toronto, Canada.

YEAR 1920

Year	Barrels	Value	Average Factory Price per Bbl.
1919	80,777,935	\$138,130,269	\$1.71
1920	100,023,245	202,046,955	2.02

The year 1920 marked the highest point in production ever credited to the industry, the figures running over 100,000,000 barrels valued at more than \$200,000,000, with average factory price \$2.02 per barrel.

Stocks at the beginning of 1920 were lower than at the beginning of any other year since records have been kept by the United States Geological Survey. At the end of the year, however, a normal quantity of cement had been made for use in 1921. In the opinion of the Government statisticians, the greatest need of the industry was steadier demand, and it was stated that efforts to bring this about were being made, but that it presented "an exceedingly complicated problem."

Trade and manufacturing conditions were better generally than in 1919, though most plants felt the cessation of demand and lowered prices at the end of the year.

There were 117 plants manufacturing in 1920 as compared with 111 in 1919. The total capacity of all mills in 1920 was estimated at 146,-400,000 barrels, production for the year being about 68 per cent of this estimated capacity.

Foreign shipments of hydraulic cements, most of it portland, showed an increase of 21 per cent. The exports for the year amounted to about 3 per cent of total production.

Companies incorporated in 1920:

Gulf States Portland Cement Company, Spocari, Alabama. (Originally the Alabama Portland Cement Company, organized in 1901.)

YEAR 1921

Year	Barrels	Value	Average Factory Price per Bbl.
1920	100,023,245	\$202,046,955	\$2.02
1921	98,842,049	186,811,473	1.89

From the foregoing figures it will be seen that 1921 recorded a decline of approximately 1 per cent in production by comparison with 1920. The price also declined, averaging at the factory \$1.89.

At the end of 1921 stocks on hand at the mills were 12,187,364 barrels, showing an increase of 38 per cent by comparison with the same time the preceding year.

During 1921 portland cement was manufactured at 115 plants, as compared with 117 plants in 1920. Six plants that were formerly active manufactured no cement during 1921—one each in Indiana, Michigan, New Jersey, New York, Oklahoma and Virginia. However, some of the idle plants shipped cement from stock.

Two new plants produced portland cement in 1921, the Petoskey at Petoskey, Michigan, and the Bessemer at Bessemer, Pennsylvania.

The plant of the Petoskey Portland Cement Company operated on the wet process, using limestone and shale as raw materials and coal as fuel. Two 10 by 150-foot kilns were operated, having a daily clinker capacity of 2,000 barrels.

The Bessemer Limestone and Cement Company operated under the wet process, using limestone and shale as raw materials and coal as fuel. This plant used three 10 by 235-foot kilns, with daily clinker capacity of 3,000 barrels.

In 1921, the hydraulic cement exported to foreign countries, including the Philippines and the Canal Zone, most of it portland cement, decreased 60 per cent in quantity and 57 per cent in value. The quantity exported in 1921 was slightly over 1 per cent of the total production of hydraulic cement in that year.

YEAR 1922

Year	Barrels	Value	Average Factory Price per Bbl.
1921	98,842,049	\$186,811,473	\$1.89
1922	114,789,984	202,030,372	1.76

New records marked the year 1922. Production was nearly 115,000,000 barrels and total shipments nearly 118,000,000 barrels. There was a still further decline in average factory price from \$1.89 to \$1.76.

The total production for the year was therefore 16 per cent over that of 1921, while shipments showed an increase of 23 per cent in quantity and

nearly 15 per cent in gross value. The average selling price at the mills showed a net decrease of nearly 7 per cent.

Of the 27 states in which portland cement was manufactured in 1922, all but five showed an increase in production and all but three showed an increase in shipments. In 1922 shipments exceeded production by 2,911,232 barrels, but this was amply taken care of by the much larger stocks carried over at the end of 1921.

Portland cement was manufactured at 118 plants in 1922 as compared with 115 in 1921.

New plants were under construction in Alabama, Iowa, Michigan, Ohio and Tennessee. Several of these plants were sufficiently near completion to enable the forecast that they would become producers in 1923.

YEAR 1923

Year	Barrels	Value	Average Factory Price per Bbl.
1922	114,789,984	\$202,030,372	\$1.76
1923	137,460,238	261,174,452	1.90

At the time this was written the United States Geological Survey, Department of Interior, had not issued its usual annual bulletin covering cement production, shipments and other statistics of the cement industry with the usual analysis of figures made in that bulletin.

However, in its preliminary report for 1923, attention is called to the fact that the quantity of portland cement produced, namely, 137,460,238 barrels, again constituted a record. This production was about 20 per cent greater than the production in 1922. Not only did production figures constitute a new record but shipments of portland cement from mills likewise made a high record, showing an increase of 15 per cent over those of 1922.

The average factory price per barrel in bulk in 1923 was \$1.90, an increase of 14 cents or 8 per cent as compared with 1922.

Manufacturing capacity showed a considerable increase over 1922 due to the fact that eight new mills were completed in 1923. The capacity of existing mills at the end of 1923 was estimated by the United States Geological Survey as 161,858,300 barrels annually.

APPENDIX C

HISTORICAL NOTES ON PORTLAND CEMENT MANUFACTURERS

The following gives a brief historical outline of each of the cement companies listed:

ACME CEMENT CORPORATION, CATSKILL, NEW YORK

Organized originally in 1912 under the name Sterling Cement Company, and changed name to Acme Cement Corporation (of New York). First cement was shipped in 1916; capacity per day 2,000 barrels. Principal officers when organized: Ormsby McHarg, President; P. T. Watt, Vice President; Walter L. Barnum, Secretary; George H. Hedge, Treasurer. In 1918 the Acme Cement Corporation (of New York) was dissolved. A new organization was formed in October, 1919, under the laws of the State of Delaware. Principal officers at present are William H. Baker, President; Charles G. Watt, Vice President; Luther G. McConnell, Secretary-Treasurer. One mill located at Alsen, N. Y. Present capacity per day 3,000 barrels. The raw materials used are limestone and clay. The wet process of manufacture is employed. Have four kilns 8 by 180 feet. Coal is used as fuel.

AETNA PORTLAND CEMENT COMPANY, DETROIT, MICHIGAN

Organized originally in 1902 under the name Detroit Portland Cement Company. First cement shipped in 1902; capacity in barrels per day 1,100. Reorganized in 1908. The principal officers are: Franklin R. Johnson, President; R. E. Paine, Secretary-Treasurer; O. J. Lingemann, General Manager. One mill located at Fenton, Michigan, and another at Bay City, Michigan. Present capacity per day 3,000 barrels. The raw materials used are marl, limestone, and clay, the wet and dry processes being used in manufacture. Have three kilns 10 by 175 feet and powdered coal is used as fuel.

ALLENTOWN PORTLAND CEMENT COMPANY, ALLENTOWN, PENNSYLVANIA

Organized in 1909 under the present name. The principal officers when first organized were: Theo. G. Wolf, President; C. A. Matchman, Vice President; C. A. Wolle, Secretary-Treasurer. First cement shipped in 1910; capacity in barrels per day 2,600. Principal officers at present are: J. W. Fuller, President; J. T. Phelan, Vice President and General Manager; R. S. Weaver, Secretary-Treasurer. One mill located at Evansville, Berks County, Pennsylvania. Present capacity per day 2,600 barrels. The raw materials used are cement rock and limestone. The dry process of manufacture is employed. Have four kilns, size 8 by 120 feet and pulverized coal is used as fuel.

ALPHA PORTLAND CEMENT COMPANY, EASTON, PENNSYLVANIA

Organized originally in 1895 under the present name. The principal officers when first organized were: George E. Bartol, President; Richard L. Austin, Treasurer; G. Walter Holloway, Secretary. First cement shipped in 1895; capacity in barrels

per day 369 $\frac{1}{2}$. Reorganized in 1910. Principal officers at present are: G. S. Brown, President; F. G. McKelvy, Vice President; F. M. Coogan, Vice President; C. A. Irvin, Vice President; John J. Matthes, Treasurer; R. S. Gerstell, Secretary. There are 10 mills located as follows: 1 at Alpha, N. J.; 2 at Martins Creek, Pa.; 1 at Cementon, N. Y.; 1 at Jamesville, N. Y.; 1 at Manheim, W. Va.; 1 at Ironton, Ohio; 1 at Bellevue, Mich; 1 at LaSalle, Ill.; 1 at St. Louis, Mo. Present capacity per day 32,000 barrels. The raw materials used are cement rock, clay, and shale. The dry process of manufacture is employed. Have 71 kilns ranging in size from 5 feet 6 inches to 10 feet in diameter and from 60 feet to 164 feet in length. Pulverized coal is used as fuel.

ASH GROVE LIME & PORTLAND CEMENT COMPANY, KANSAS CITY, MISSOURI

Organized originally in 1880 under the name Ash Grove White Lime Association. Principal officers when first organized: W. B. Hill, President; O. J. Hill, Vice President; J. H. Barton, Secretary; J. F. Pollock, Treasurer. First cement shipped in 1908; capacity per day 2,000 barrels. Reorganized in 1907 under the name Ash Grove Lime & Portland Cement Company. Principal officers at present are: L. T. Sunderland, President; J. A. Sunderland, First Vice President; J. F. Pollock, Vice President and Treasurer in charge of Sales, Traffic; W. P. Sabin, Secretary and Assistant to President. One mill located at Chanute, Kans. Present capacity per day 4,167 barrels. Raw materials used are rock and shale. The wet process of manufacture is employed. Have six kilns, five of which are 8 by 125 feet and one 9 by 8 by 200 feet. Coal, fuel oil, and gas are used as fuel.

THE ATLAS PORTLAND CEMENT COMPANY, NEW YORK CITY.

Organized in 1899 under the present name. First cement shipped in 1895. Principal officers at present are: John R. Morron, President; A. de Navarro, Vice President; Howard W. Maxwell, Vice President; L. R. Burch, Vice President; D. H. MacFarland, Assistant to President; W. E. Miner, Secretary-Treasurer. There are nine mills located as follows: 3 at Northampton, Pennsylvania; 1 at Coplay, Pennsylvania; 2 at Hannibal, Missouri; 1 at Leeds, Alabama; 1 at Hudson, New York (operated by subsidiary company—New York and New England Cement & Lime Company); 1 at Independence, Kansas (operated by subsidiary company—The Atlas Portland Cement Company of Kansas). Present capacity per day 52,800 barrels. The raw materials used are limestone, clay, cement rock, shale, and sand rock. The dry process of manufacture is employed. Coal, oil, and natural gas is used for fuel.

BATH PORTLAND CEMENT COMPANY, PHILADELPHIA.

Organized in 1904 under the present name. Principal officers when first organized were: G. W. Roydhouse, George Miller, and Fred B. Franks. First cement was shipped in 1905; capacity per day 2,500 barrels. Principal officers at present time are: John Barnes, President; Fred B. Franks, Vice President; R. O. Althouse, Secretary. One mill located at Bath, Pa. Present capacity per day 3,100 barrels. The raw material used is cement rock. The dry process of manufacture is employed. Have seven kilns, 7 feet 6 inches by 100 feet. Coal is used for fuel.

BEAVER PORTLAND CEMENT COMPANY, PORTLAND, OREGON.

Organized originally in 1913 under the present name. Principal officers when organized were: J. C. Burch, President; Wm. Schrupp, Vice President; C. S. Woody, Secretary-Treasurer. First cement was shipped in 1920. Reorganized in 1919 and the principal officers at present are: D. L. Carpenter, President; W. H. Muirhead, Vice President; L. H. Adams, Secretary. One mill located at Gold

Hill, Oregon. Present capacity per day 1,000 barrels. The raw materials used are limestone and shale. The wet process of manufacture is employed. Have one kiln and crude oil is used as fuel.

BESSEMER LIMESTONE & CEMENT COMPANY, YOUNGSTOWN, OHIO.

Organized originally in 1887 under the name Bessemer Limestone Company. The principal officers when originally organized were: J. G. Butler, Jr., President; W. B. Schiller, Secretary-Treasurer. Reorganized in 1888. In 1919 the name Bessemer Limestone and Cement Company was adopted. First cement was shipped in 1921; capacity per day 3,000 barrels. The principal officers at present are: J. G. Butler, Jr., Chairman, Board of Directors; John Tod, President; R. C. Steese, Vice President; F. R. Kanengeiser, Vice President and General Manager; G. G. Treat, Secretary-Treasurer. One mill located at Bessemer (Post Office), Lawrence County, Walford (shipping point), Pennsylvania. Present capacity per day 3,700 barrels. The raw materials used are limestone and shale. The wet process of manufacture is employed. Have three 10 by 175-foot kilns with an 8 by 60-foot extension. Pulverized coal used as fuel.

CALIFORNIA PORTLAND CEMENT COMPANY, LOS ANGELES, CALIFORNIA.

Principal officers are: Dan Murphy, President; Marco H. Hellman, Vice President; T. J. Fleming, Secretary-Treasurer, General Manager, and Purchasing Sales Agent. Capacity per day 4,500 barrels. Mill located at Colton. Dry process of manufacture is employed. Have five 8 by 7 by 120-foot kilns and three 8½ by 150-foot kilns. Oil is used for fuel.

CASTALIA PORTLAND CEMENT COMPANY, PITTSBURGH, PENNSYLVANIA.

Principal officers are: J. D. Rhodes, President; J. Twin Brooks, Vice-President and General Manager; Andrew Muirhead, Secretary; C. Salmond, Treasurer. Capacity per day 2,200 barrels. Mill located at Castalia, Ohio. Wet process of manufacture is employed. Have seven kilns, two 8 by 120 feet and five 6 by 125 feet. Coal is used as fuel.

CLINCHFIELD PORTLAND CEMENT CORPORATION, KINGSPORT, TENNESSEE.

Organized in 1910 under the present name. Principal officers when organized were: John A. Miller, President; H. R. Dennis, Vice President; W. M. Bennett, Secretary-Treasurer; E. G. Woodling, Assistant Secretary. First cement was shipped in 1911; capacity per day 1,333 barrels. Principal officers at present are: John A. Miller, President; James A. Blair, Jr., First Vice President; H. R. Dennis, Vice President; Warren P. Eaton, Secretary; W. M. Bennett, Jr., Treasurer and Assistant Secretary; F. Guenther, Jr., General Manager. One mill located at Kingsport, Tenn. Present capacity per day 4,000 barrels. The raw materials used are limestone and shalestone. The dry process of manufacture is employed. Have six kilns, 8 by 125 feet. Coal is used for fuel.

THE COLORADO PORTLAND CEMENT COMPANY, DENVER, COLORADO.

Organized originally in 1901 under the name Portland Cement Company. Principal officers when organized were: John A. Thatcher, President; C. Leonardt, Vice President; M. B. Loy, Secretary-Treasurer. First cement was shipped in 1902. Reorganized in 1908 under the name The Colorado Portland Cement Company. The principal officers at present are: Charles Boettcher, President; C. K. Boettcher, Vice President and Treasurer; R. J. Morse, Secretary. One mill located at Portland, Colorado. Present capacity per day 3,000 barrels. The

raw materials used are lime and shale. The dry process of manufacture is employed. Have five kilns, one 9 by 120 feet, two 8 by 120 feet, and two $7\frac{1}{2}$ by 120 feet. Coal is used for fuel.

COPLAY CEMENT MANUFACTURING COMPANY, COPLAY, PENNSYLVANIA.

Organized originally under the name Coplay Cement Company, Allentown, Pa. Principal officers when organized were: David O. Saylor, President; Adam Woolver, Secretary; Esias Rehrig, Treasurer. First cement was shipped in 1874; capacity per day 200 to 300 barrels. Reorganized in 1901 and adopted the present name. Principal officers at present are: Herbert E. Steiner, President; Eugene Blum, Chairman; Sol Kohn, Vice President; Abraham Israel, Vice President; George A. Christ, Secretary-Treasurer. Two mills located at Coplay and Saylor, Pennsylvania. Present capacity per day 5,000 barrels. The raw materials used are limestone and cement rock. The dry process of manufacture is employed. Have seven kilns, four 7 by 120, one 9 by 120, and two 9 by 125 feet. Gas and coal are used as fuel.

COWELL PORTLAND CEMENT COMPANY, SAN FRANCISCO, CALIFORNIA.

Organized in 1907 under the present name. Principal officers when organized were: E. V. Cowell, President; S. H. Cowell, Vice President; Miss H. E. Cowell, Treasurer; W. H. George, Secretary and General Manager. First cement shipped in 1909; capacity per day 4,500 barrels. Principal officers at present are: S. H. Cowell, Vice President; Miss H. E. Cowell, Treasurer; W. H. George, Secretary and General Manager. One mill located at Cowell, Contra Costa County, California. Present capacity per day 4,500 barrels. The raw materials used are lime, clay, and silica sand. The dry process of manufacture is employed. Have eight kilns, $7\frac{1}{2}$ by 110. Oil is used as fuel for burning clinker.

CRESCENT PORTLAND CEMENT COMPANY, WAMPUM, PENNSYLVANIA.

Organized originally in 1875 under the name Wampum Mining & Manufacturing Company. Principal officers when organized were: W. P. Shinn, President; John K. Shinn, Secretary-Treasurer. Capacity per day 300 barrels. Reorganized, changing the name to National Cement Company. The present organization is known as the Crescent Portland Cement Company. The principal officers are: David M. Kirk, President and General Manager. One mill located at Crescentdale Station (Wampum, P. O.), Pennsylvania. Present capacity per day 3,500 barrels. The raw materials used are limestone and shale.

DEWEY PORTLAND CEMENT COMPANY, KANSAS CITY, MISSOURI.

Organized in 1906 under the present name. Principal officers when organized were: F. E. Tyler, President and General Manager; T. S. Williamson, Vice President; J. H. Keith, Secretary; J. R. Mulsane, Treasurer. First cement was shipped in 1908; capacity per day 2,000 barrels. Principal officers at present are: F. E. Tyler, President and General Manager; H. F. Tyler, Vice President; A. L. Frank, Vice President; R. W. Moore, Secretary; W. E. Tyler, Treasurer. One mill located at Dewey, Oklahoma. Present capacity per day 4,000 barrels. The raw materials used are limestone and shale. The dry process of manufacture is employed. Have six kilns, $9\frac{1}{2}$ by 100. Coal is used for fuel.

DEXTER PORTLAND CEMENT COMPANY, NAZARETH, PENNSYLVANIA.

Organized in 1899 under the present name. Principal officers when organized were: Geo. E. Bartol, President; Wm. B. Newberry, Secretary-Treasurer. First cement was shipped in 1901. Capacity per day 500 barrels. Principal officers at present are: John A. Miller, President; Joseph Brobston, First Vice President and General

Manager; M. T. Swartz, Second Vice President; Clarence F. Fehnel, Secretary; Harry L. Worman, Treasurer. One mill located at Nazareth, Pennsylvania. Present capacity per day 3,900 barrels. The raw material used is cement rock. The dry process of manufacture is employed. Have six 7 foot 6 inch by 100 foot kilns and two 8 foot by 100 foot kilns. Pulverized coal is used as fuel.

THE DIAMOND PORTLAND CEMENT COMPANY, CLEVELAND, OHIO.

Organized originally in 1892 under the present name. Principal officers when organized were: Z. W. Davis, President; W. G. Alcott, Vice President and Secretary-Treasurer. First cement was shipped in 1893; capacity per day 80 barrels. Reorganized in 1897. The principal officers at present are: Z. W. Davis, President; F. L. Alcott, Vice President; L. A. Reed, Secretary-Treasurer. One mill is located at Middle Branch, Stark County, Ohio. Present capacity per day 2,500 barrels. The raw materials used are lime rock, shale and clay. The dry process of manufacture is employed. Have two kilns 10 by 150 feet. Coal is used as fuel.

DIXIE PORTLAND CEMENT COMPANY, CHATTANOOGA, TENNESSEE.

Organized in 1906 under the present name. Principal officers when organized were: George E. Nicholson, President; A. B. Cockerill, Vice President; L. L. Northrup, Treasurer; Richard Hardy, Secretary. First cement was shipped in 1907. Capacity per day 2,000 barrels. Principal officers at present are: Richard Hardy, President; George W. Millen, Vice President; George Kilian, Secretary-Treasurer. One mill located at Richard City, Tennessee. Present capacity per day 5,000 barrels. The raw materials used are limestone and shale. The wet process of manufacture is employed. Have nine kilns 8 by 110 feet. Coal is used as fuel.

EDISON PORTLAND CEMENT COMPANY, ORANGE, NEW JERSEY.

Organized in 1899 under the present name. Principal officers when organized were: William H. Shelmerdine, President; Walter S. Mallory, Vice President; William S. Pilling, Secretary-Treasurer. First cement was shipped in 1905; capacity per day 3,000 barrels. Principal officers at present are: Thomas A. Edison, Chairman, Board; Charles Edison, President; W. D. Cloos, Vice President and General Manager; Harry F. Miller, Treasurer; R. A. Wetzler, Vice President and District Manager at New York; A. C. Bruff, Vice President and District Manager at Boston; J. W. Robinson, Secretary. One mill located at New Village, New Jersey. Present capacity per day 7,500 barrels. The raw materials used are cement rock, limestone. The dry process of manufacture is employed. Have ten kilns 150 feet long (6 feet 11 inches by 105 feet upper end, 7 feet 8 inches by 45 feet lower end). Coal is used as fuel.

FREDONIA PORTLAND CEMENT COMPANY, FREDONIA, KANSAS.

Organized in 1906. Principal officers when organized were: E. S. Rea, President; F. H. Patterson, Vice President and Treasurer; A. P. Erwin, Secretary. First cement was shipped in 1907; capacity per day 500 barrels. Principal officers at present are F. H. Patterson, President; Mrs. F. H. Patterson, Vice President; F. C. Doggett, Secretary-Treasurer. One mill located at Fredonia, Kansas. Present capacity per day 1,500 barrels. The raw materials used are lime rock and shale. The wet process of manufacture is employed. Have three kilns 7 feet by 160 feet. Gas, oil, and coal are used as fuel.

GEORGIA CEMENT & STONE COMPANY, BIRMINGHAM, ALABAMA.

Principal officers are: George E. Nicholson, President; Ralph E. Nicholson, Vice President; George A. Nicholson, Secretary-Treasurer. Mills located at Portland, Georgia. Capacity per day 1,500 barrels. The dry process of manufacture is employed. Have two kilns 8 by 125 feet. Coal is used as fuel.

GIANT PORTLAND CEMENT COMPANY, PHILADELPHIA, PENNSYLVANIA.

Organized originally in 1883 under the name American Improved Cements Company. Principal officers when organized were: Robert W. Lesley, President; Geo. W. Norris, Vice President; F. J. Jiggins, Treasurer; J. F. Lennig, Secretary. Capacity in barrels per day 8,000. Reorganized in 1912 under the name American Cement Company. In 1913 the name Giant Portland Cement Company was adopted. Principal officers at present are: Chas. F. Conn, President; W. L. Haehnlen, Vice President; F. J. Jiggins, Treasurer; J. F. Lennig, Secretary. Two mills located at Egypt, Lehigh County, Pennsylvania. Present capacity per day 6,000 barrels. The raw materials used are cement rock and limestone. The dry process of manufacture is employed. Have eight kilns 6 feet by 60 feet and six kilns 7 feet by 125 feet. Gas and coal used as fuel.

GILMORE PORTLAND CEMENT CORPORATION, GILMORE CITY, IOWA

Organized in 1911 under the name Fort Dodge Portland Cement Corporation. Principal officers when organized were: M. J. Nicholson, President; L. H. Van Alstine, Vice President; H. S. Van Alstine, Secretary-Treasurer. First cement was shipped in 1914; capacity in barrels per day 1,200. Principal officers at present are: A. C. Brown, President; L. H. Van Alstine, Vice President; H. S. Van Alstine, Secretary-Treasurer. One mill located at Gilmore City, Iowa. Present capacity per day 1,200 barrels. The raw materials used are limestone and shale. The dry process of manufacture is employed. Have two kilns 9 by 124 feet. Coal is used as fuel.

GLENS FALLS PORTLAND CEMENT COMPANY, GLENS FALLS, NEW YORK.

Organized in 1893 under the present name. Principal officers when organized were Wm. W. McClay, President; S. L. Goodman, Vice President; A. W. Sherman, Treasurer; J. E. Parry, Secretary. First cement was shipped in 1894; capacity per day 200 barrels. Principal officers at present are: Geo. F. Bayle, President; Byron Lapham, Vice President; Geo. F. Bayle, Jr., Second Vice President; J. E. Parry, Secretary; A. W. Sherman, Treasurer. One mill located at Glens Falls, New York. Present capacity per day 3,600 barrels. The raw materials used are cement rock, limestone, and clay. The wet process of manufacture is employed. Have two kilns 10 feet by 250 feet and four kilns 7½ feet by 7 feet by 120 feet. Bituminous coal is used as fuel.

GOLDEN STATE PORTLAND CEMENT COMPANY, LOS ANGELES, CALIFORNIA.

Organized in 1907 under the present name. Principal officers when organized were: F. O. Wyman, President; V. H. Graham, Vice President; E. M. Potts, Secretary. First cement was shipped in 1911; capacity per day 600 barrels. Principal officers at present are Griffith Henshaw, Vice President; John Treanor, Vice President and General Manager; Wm. H. Metcalf, Secretary. One mill located at Oro Grande, California. Present capacity per day 5,000 barrels. The raw materials used are limestone and shale. The dry process of manufacture is employed. Have seven kilns, 8 feet by 125 feet. Fuel oil is used as fuel.

THE GREAT WESTERN PORTLAND CEMENT COMPANY, KANSAS CITY, MISSOURI.

Organized originally in 1906 under the name The Great Western Portland Cement Company of Kansas. Principal officer when organized was J. W. Wagner, President. First cement was shipped in 1909; capacity per day 1,000 barrels. Reorganized in 1912, and in 1922 adopted the name The Great Western Portland Cement

Company. Principal officers at present are: L. L. Seibel, President; Page Golsan, Vice President; William Volker, Secretary-Treasurer. One mill located at Mildred, Kansas. Present capacity per day 3,000 barrels. The raw materials used are limestone and clay. The wet process of manufacture is employed. Have three kilns and use gas, oil, and coal as fuel.

GULF STATES PORTLAND CEMENT COMPANY, DEMOPOLIS, ALABAMA.

Organized originally in 1901 under the name Alabama Portland Cement Company. Principal officers when organized were: R. C. Lebiens, President; Ralph Law, Secretary-Treasurer; Geo. P. Dieckman, Vice President. Capacity in barrels per day 300. Reorganized in 1919 under the name Gulf States Portland Cement Company. Principal officers at present are: A. Tonnar, President; Henry McDaniel, Secretary-Treasurer; A. B. Wilder, Vice President; J. F. Jones, Vice President. One mill located at Spocari, Alabama. Present capacity per day 1,000 barrels. The raw materials used are chalky limestone and clay. The dry process of manufacture is employed. Have five 6 foot by 60 foot kilns. Coal is used as fuel.

HAWKEYE PORTLAND CEMENT COMPANY, DES MOINES, IOWA

Organized originally in 1908 under the name Iowa Portland Cement Company. Principal officers when organized were: Geo. E. Nicholson, President; J. C. Burch, Secretary-Treasurer. First cement was shipped in 1910; capacity per day 2,000 barrels. Reorganized in 1916 under the name Hawkeye Portland Cement Company. Principal officers at present are: L. C. Colman, President; L. F. Crofoot, Vice President; C. W. Hull, Treasurer; C. B. Condon, Secretary and General Manager. One mill located at Des Moines, Iowa. Present capacity per day 4,500 barrels. The raw materials used are limestone and shale. The wet process of manufacture is employed. Have six 9 by 125 foot kilns. Coal is used as fuel.

THE HELDERBERG CEMENT COMPANY, ALBANY, NEW YORK.

Organized in 1898. Principal officers were: T. H. Dumary, President; Chas. E. Lee, Vice President; C. H. Ramsey, Secretary-Treasurer. Capacity in barrels per day 100. Principal officers at present are: F. W. Kelley, President; Frederic Pruyn, Vice President; W. L. L. Peltz, Secretary; Chas. R. Parks, Treasurer. One mill located at Howes Cave, New York. Present capacity per day 2,000 barrels. The raw materials used are limestone and clay. The wet process of manufacture is employed. Have two kilns 10 feet by 9 feet by 170 feet. Coal is used as fuel.

HERCULES CEMENT CORPORATION, PHILADELPHIA, PENNSYLVANIA.

Organized in 1916 under the present name. The principal officers when organized were: Morris Kind, President; Thomas M. Pierce, Secretary-Treasurer. First cement was shipped in 1917. Principal officers at present are: Morris Kind, President; Lorin C. Powers, Secretary-Treasurer. One mill located at Stockertown, Pa. Capacity per day 3,000 barrels. The raw material used is cement rock. The dry process of manufacture is employed. Have six 7 foot 6 inch by 7 foot by 125 foot kilns. Coal is used as fuel.

HERMITAGE PORTLAND CEMENT COMPANY, NASHVILLE, TENNESSEE.

Organized in 1921 under the present name. Principal officers when organized were: John C. Vance, President; T. L. Herbert, Jr., Vice President; R. T. Miller, Secretary-Treasurer. First cement was shipped in 1924; capacity per day 2,000 barrels. Principal officers at present are: John C. Vance, President; T. L. Herbert, Jr., Vice President; R. D. Herbert, Secretary-Treasurer; R. T. Miller, General Manager. One mill located in Nashville, Tennessee. Present capacity per day 2,000 barrels. The raw materials used are limestone and clay. The wet process of manufacture is employed. Have two 10 foot by 150 foot kilns. Coal is used as fuel.

HURON PORTLAND CEMENT COMPANY, DETROIT, MICHIGAN.

Organized in 1907 under the present name. Principal officers when organized were: J. B. Ford, President; E. L. Ford, Vice President; S. T. Crapo, Secretary-Treasurer. First cement shipped in 1908; capacity per day 3,000 barrels. Principal officers at present are: J. B. Ford, President; E. L. Ford, Vice President; John W. Boardman, Vice President; S. T. Crapo, Secretary-Treasurer. One mill located at Alpena, Michigan. Present capacity per day 10,000 barrels. The raw materials used are Alpena limestone and shale. The dry process of manufacture is employed. Have eight 8 by 110 foot kilns and three 10 by 150 foot kilns. Coal is used as fuel.

INDIANA PORTLAND CEMENT COMPANY, INDIANAPOLIS, INDIANA.

Organized in 1917 under the present name. Principal officers when organized were: Adam L. Beck, President; Peter Martin, Vice President; W. H. Hart, Secretary; Marshall Beck, Treasurer and Purchasing Agent. First cement shipped in 1919; capacity per day 1,200 barrels. Principal officers at present are: Adam L. Beck, President; Bert B. Williams, Vice President and Purchasing Agent; W. H. Hart, Secretary; Marshall Beck, Treasurer. One mill located at Limesdale, Indiana (Post Office Greencastle, Indiana). Present capacity per day 4,000 barrels. The raw materials used are limestone and shale. The wet process of manufacture is employed. Have three 10 foot by 240 foot kilns. Coal is used in kilns for fuel and power is purchased.

INTERNATIONAL CEMENT CORPORATION, NEW YORK, NEW YORK.

Organized in 1919 under the present name. Principal officers when organized were: F. R. Bissell, Chairman, Board; H. Struckmann, President; R. F. Hoyt, Vice President; J. R. Dillon, Treasurer; A. J. Ronaghan, Secretary. Capacity per day 14,700 barrels. Principal officers at present are: F. R. Bissell, Chairman, Board; H. Struckmann, President; R. F. Hoyt, Vice President; Ejnar Posselt, Vice President; Baxter D. McClain, Secretary; J. R. Dillon, Treasurer. Five mills located as follows: Dallas, Texas; Houston, Texas; Hudson, New York; Bonner Springs, Kansas; Norfolk, Virginia. Present capacity per day 27,000 barrels. The raw materials used at the different mills are Dallas—rock and shale; Houston—shells and clay; Hudson—rock and clay; Bonner Springs—rock and shale; Norfolk, —marl and clay. Wet process of manufacture employed in all plants.

INTERNATIONAL PORTLAND CEMENT COMPANY, LTD., SPOKANE, WASHINGTON.

Organized in 1910. Principal officers when organized were: J. S. Irvin, President; F. W. Dewart, Vice President and Treasurer; H. W. Wood, Secretary. First cement shipped in 1913; capacity per day 1,500 barrels. Principal officers at present are: Wm. F. Powell, President; R. K. Neill, Vice President; John P. Hartman, Secretary; C. A. Irvin, Treasurer. One mill located at Irvin, Wash. Present capacity per day 1,500 barrels. The raw materials used are cement rock, limestone and shale. The dry process of manufacture is employed. Have two 8 foot 6 inch by 160 foot kilns. Powdered coal is used as fuel.

THE KANSAS PORTLAND CEMENT COMPANY, KANSAS CITY, MISSOURI.

Organized originally in 1919 under the name Bonner Portland Cement Company. Principal officers when organized were: W. H. Caffery, President; Chas. Knabb, Vice President; A. L. Cooper, Secretary; J. D. Waters, Treasurer. Capacity per day 600 barrels. Reorganized in 1923 under the name The Kansas Portland Cement Company. Principal officers at present are: F. R. Bissell, Chairman, Board; H. Struckmann, President and General Manager; J. A. Lehaney, Vice President and Sales Manager; Baxter D. McClain, Secretary; C. N. Peters, Treasurer and

Assistant Secretary. One mill located at Sunflower Station, one mile east of Bonner Springs, Kansas. Present capacity per day 3,300 barrels. The raw materials used are rock and shale. The wet process of manufacture is employed. Have three 8 by 9 by 225 foot kilns. Coal is used as fuel.

KNICKERBOCKER PORTLAND CEMENT COMPANY, INC., ALBANY, NEW YORK.

Organized originally in 1908 under the name Knickerbocker Portland Cement Company. Principal officers when organized were: Sheldon H. Bassett, President; Benjamin Briscoe, Vice President; J. D. Dalton, Secretary; Thomas F. Stevenson, Treasurer. First cement was shipped in 1911; capacity per day 3,000 barrels. Reorganized in 1918 under the name Knockerbocker Portland Cement Company, Inc. Principal officers at present are: F. R. Bissell, Chairman, Board; H. Struckmann, President; Charles L. Hogan, Vice President; Baxter D. McClain, Secretary; H. H. Muehlke, Treasurer and Assistant Secretary. One mill located at Hudson, New York. Present capacity per day 5,000 barrels. The raw materials used are limestone and clay. The wet process of manufacture is employed. Have four 10 foot by 175 foot kilns with waste heat boilers. Coal is used as fuel.

KOSMOS PORTLAND CEMENT COMPANY, KOSMOSDALE, KENTUCKY.

Organized in 1904 under the present name. Principal officers when organized were: Samuel Horner, Jr., President; Robert Horner, Vice President and Treasurer; A. McCracken, Secretary. First cement was shipped in 1905; capacity per day 1,200 barrels. Principal officers at present are: Charles Horner, President; O. M. Clark, Vice President; Albert W. Horner, Vice President; Francis H. K. Hogue, Secretary-Treasurer. One mill located at Kosmosdale, Jefferson County, Kentucky. Present capacity per day 2,500 barrels. The raw materials used are limestone and clay. The dry process of manufacture is employed. Have four 7 by 6 by 80 foot kilns and two 8½ by 125 foot kilns. Coal is used as fuel.

LAWRENCE PORTLAND CEMENT COMPANY, SIEGFRIED, PENNSYLVANIA.

Organized originally in 1889 under the name The Lawrence Cement Company. Principal officers when organized were: Warren Ackerman, President; Geo. S. Coutant, Vice President; Thomas A. Smith, Secretary-Treasurer. First cement shipped in 1889; capacity per day 10 barrels. Reorganized in 1898 under the name The Lawrence Cement Company of Pennsylvania. In 1909 adopted the name Lawrence Portland Cement Company. Principal officers at present are: Frank H. Smith, President; Marion S. Ackerman, Vice President; Charles A. Porter, Third Vice President; J. S. VanMiddlesworth, Secretary; H. R. Munger, Treasurer. One mill located at Siegfried, Pennsylvania. The raw materials used are cement rock and limestone. The dry process of manufacture is employed. Have four 6 foot by 110 foot kilns, one 7½ foot by 6 foot by 110 foot kiln, three 7 foot by 110 foot kilns and two 8 foot by 110 foot kilns. Gas and coal used as fuel.

LEHIGH PORTLAND CEMENT COMPANY, ALLENTOWN, PENNSYLVANIA.

Organized in 1897 under the present name. Principal officers when organized were: Harry C. Trexler, President; George Ormrod, Vice President; E. M. Young, Secretary-Treasurer. First cement shipped in 1898; capacity per day 800 barrels. Principal officers at present are: Harry C. Trexler, President; E. M. Young, First Vice President; D. E. Ritter, Second Vice President; Alonzo F. Walter, Secretary-Treasurer. Sixteen mills located as follows: Three at Ormrod and three at New Castle, Pennsylvania; two at Mitchell, Indiana; and one each at West Coplay, Pennsylvania, Fogelsville, Pennsylvania, Fordwick, Virginia, Mason City, Iowa, Oglesby,

Illinois, Iola, Kansas, Metaline Falls, Washington, and Birmingham, Alabama. Present capacity per day 48,000 barrels. The raw materials used are limestone, cement rock, shale, and clay. The wet process of manufacture is employed at two mills and the dry process at 14 mills. Coal, gas and oil are used as fuel.

LOUISVILLE CEMENT COMPANY, LOUISVILLE, KENTUCKY.

Organized originally in 1866 under the name Louisville Cement & Water Power Company. Principal officers when organized were: Milton M. Rhorer, President; Joshua F. Speed, Secretary; Louisville Savings Institute, Treasurer. First natural cement shipped in 1826 and first portland cement shipped in 1906; capacity per day 300 barrels. Reorganized in 1869 under the name Louisville Cement Company. Principal officers at present are: W. S. Speed, President; F. M. Sackett, Vice President; Henry S. Gray, Secretary-Treasurer. One mill located at Speed, Clark County, Indiana. Present capacity per day 7,500 barrels. The raw materials used are limestone and shale. The dry process of manufacture is employed. Have two 10 by 150 foot kilns, two 10 to 8 by 160 foot kilns and two 7 by 100 foot kilns. Coal is used as fuel.

MANITOWOC PORTLAND CEMENT COMPANY, MANITOWOC, WISCONSIN.

Organized in 1923 under the present name. Principal officers when organized were: Charles C. West, President; L. E. Geer, Secretary-Treasurer; J. B. John, Vice President and General Manager. First cement shipped in 1924. Principal officers at present are: Charles C. West, President; L. E. Geer, Secretary-Treasurer; J. B. John, Vice President and General Manager. One mill located at Manitowoc, Wisconsin. Present capacity per day 3,000 barrels. The raw materials used are limestone and clay. The wet process of manufacture is employed. Have three 10 foot by 160 foot kilns. Coal is used as fuel.

MARQUETTE CEMENT MANUFACTURING COMPANY, CHICAGO, ILLINOIS.

Organized originally in 1898 under the name Marquette Cement Company. First cement was shipped in 1899; capacity per day 250 barrels. Reorganized in 1903 under the name Marquette Cement Manufacturing Company. Principal officers at present are: Theodore G. Dickinson, President; William Dickinson, Vice President; Robert B. Dickinson, Vice President and General Manager; Sellar Bullard, Vice President; Walter A. Wecker, Secretary-Treasurer. Two mills located at LaSalle, Illinois, and Cape Girardeau, Missouri. Present capacity per day 11,500 barrels. The raw materials used are rock, shale, and clay. The dry process of manufacture is employed. Have seven 9 by 100 foot kilns and three 9 by 130 foot kilns. Pulverized coal is used as fuel.

MICHIGAN PORTLAND CEMENT COMPANY, CHELSEA, MICHIGAN.

Plant has been leased and will be operated by Michigan State Industries. Principal officers are: N. S. Potter, Jr., President and General Manager; C. Z. Potter, Vice President and Secretary; K. L. Potter, Treasurer. Capacity per day 2,100 barrels. Wet process of manufacture is employed. Have three kilns 8 by 125 feet. Coal is used as fuel.

MISSOURI PORTLAND CEMENT COMPANY, ST. LOUIS, MISSOURI.

Organized originally in 1891 under the name Union Sand Company. Principal officers when organized were: H. L. Block, President; A. H. Craney, Jr., Vice President; H. P. Johnson, Vice President; C. A. Cunningham, Secretary; C. G. Besch, Treasurer. First cement was shipped in 1902; capacity per day 2,000 barrels. Reorganized in 1917 under the name Missouri Portland Cement Company. Principal officers at present are: H. L. Block, President; C. A. Homer, Vice

President; C. G. Besch, Vice President and Treasurer; Geo. M. Block, Vice President; R. S. Colnon, Vice President; John H. Soell, Secretary and Purchasing Agent. Two mills located at Prospect Hill, Missouri, and Sugar Creek, Missouri. Present capacity per day at Prospect Hill 5,000 barrels and at Sugar Creek 3,000 barrels. The raw materials used are limestone and shale. Wet process of manufacture is employed at Prospect Hill and the dry process at Sugar Creek. At Prospect Hill have two 11 foot 3 inch by 240 foot kilns and six 8 foot by 120 foot kilns, and at Sugar Creek four 8 foot by 125 foot kilns. Powdered coal is used as fuel.

THE MONARCH CEMENT COMPANY, HUMBOLDT, KANSAS.

Organized originally in 1907 under the name The Monarch Portland Cement Company. Principal officers when organized were: O. M. Connett, President; William Keith, Secretary-Treasurer. Capacity per day 2,000 barrels. Reorganized in 1913 under the name The Monarch Cement Company. Principal officers at present are: H. F. G. Wulf, President; Fred H. Rhodes, Secretary-Treasurer. One mill located at Humboldt, Allen County, Kansas. Present capacity per day 4,000 barrels. The raw materials used are rock and shale. The dry process of manufacture is employed. Have eight 8 foot by 125 foot kilns. Gas, oil and coal used as fuel.

MONOLITH PORTLAND CEMENT COMPANY, LOS ANGELES, CALIFORNIA.

Organized originally in 1920 under the name United States Potash Company. Principal officers when organized were: Fred A. Ballin, President; Aman Moore, Vice President; Coy Burnett, Secretary-Treasurer. First cement was shipped in 1920; capacity per day 1,000 barrels. Reorganized in 1921 under the name Monolith Portland Cement Company. Principal officers at present are: Coy Burnett, President; Wilmar Evans, Vice-President; J. J. Calkins, Secretary-Treasurer. One mill located at Monolith, Kern County, California. Present capacity per day 2,500 barrels. The raw materials used are limestone and clay. The wet process of manufacture is employed. Have two 9 by 125 foot kilns, one 9 by 200 foot kiln and one 11½ by 200 foot kiln. Oil is used as fuel.

NATIONAL CEMENT COMPANY, BIRMINGHAM, ALABAMA.

Principal officers are: Geo. E. Nicholson, President; Ralph E. Nicholson, Vice President; Frank G. Conkling, Assistant to the President in Charge of Sales; Geo. A. Nicholson, Secretary-Treasurer. One mill located at Ragland, Alabama. Dry process of manufacture is employed. Have two 8 by 125 foot kilns and two 9 by 125 foot kilns. Present capacity per day 2,500 barrels. Coal is used as fuel for burning.

NAZARETH CEMENT COMPANY, NAZARETH, PENNSYLVANIA.

Organized originally in 1906. Principal officers when organized were: A. M. Young, President; M. J. Warner, Vice President; P. H. Hampson, Treasurer; Geo. F. Coffin, Secretary. First cement shipped in 1906; capacity per day 1,200 barrels. Reorganized in 1918. Principal officers at present are: M. J. Warner, President; J. W. Louder, Assistant to President; Geo. F. Coffin, Secretary-Treasurer; Alfred L. Ferguson, Vice President and Assistant Treasurer. One mill located at Nazareth, Pennsylvania. Present capacity per day 4,800 barrels. The raw material used is cement rock. The dry process of manufacture is employed. Have four 7 by 120 foot kilns, three 7 foot 6 inch by 120 foot kilns and one 9 by 120 foot kiln. Bituminous coal is used as fuel.

NEBRASKA CEMENT COMPANY, DENVER, COLORADO.

Organized in 1917 under the present name. Principal officers when organized were: C. Boettcher, President; E. E. Bruce, Vice President; R. J. Morse, Secretary; C. Boettcher, Treasurer. First cement was shipped in 1918; capacity per day 2,500

barrels. Principal officers at present are: Charles Boettcher, President and Treasurer; E. E. Bruce, Vice President; R. J. Morse, Secretary. One mill located at Superior, Nebraska. Present capacity per day 2,500 barrels. The raw materials used are lime and shale. The wet process of manufacture is employed. Have three 9½ by 8 by 200 foot kilns. Coal is used as fuel.

NEWAYGO PORTLAND CEMENT COMPANY, NEWAYGO, MICHIGAN.

Organized originally in 1899 under the present name. Principal officers when organized were: D. McCool, President; Wm. Wright, Vice President; B. T. Becker, Secretary-Treasurer. First cement was shipped in 1901; capacity per day 500 barrels. Reorganized in 1911. Principal officers at present are: Clay H. Hollister, President; J. B. John, Vice President and General Manager; L. E. Geer, Vice President; W. A. Ansoerge, Treasurer and Assistant General Manager; C. E. Wyman, Secretary. One mill located at Newaygo, Michigan. Present capacity per day 3,000 barrels. The raw materials used are limestone and shale. The wet process of manufacture is employed. Have three 9 by 160 foot kilns. Coal is used as fuel.

NEW EGYPTIAN PORTLAND CEMENT COMPANY, DETROIT, MICHIGAN.

Organized in 1901 under the name Egyptian Portland Cement Company. Principal officers when organized were: Harry J. Paxton, President; Walter B. Cary, Vice President; Charles H. Paxton, Secretary-Treasurer. Principal officers at present are: Maynard D. Smith, President; E. R. Sullivan, Vice President; C. A. Bray, Secretary-Treasurer. Two mills located at Port Huron, Michigan, and Fenton, Michigan. Present capacity per day 3,200 barrels. The raw materials used at Port Huron are rock and clay and at Fenton, marl and clay. Have nine 6 by 60 foot kilns at Fenton and one 11 foot 3 inch by 200 foot kiln at Port Huron. Coal is used as fuel.

NORTHWESTERN STATES PORTLAND CEMENT COMPANY, MASON CITY, IOWA.

Principal officers are: C. H. McNider, President; A. F. Frudden, Vice President; F. E. Keeler, Treasurer; F. G. Ray, Secretary. One mill located at Mason City, Iowa. Capacity per day 8,350 barrels. The dry process of manufacture is employed. Have twelve kilns, two 8 by 110 foot and ten 7 by 110 foot. Coal is used as fuel.

THE OGDEN PORTLAND CEMENT COMPANY, OGDEN, UTAH.

Organized in 1909 under the present name. Principal officers when organized were: W. J. Bell, President and General Manager; R. E. Bristol, Secretary-Treasurer; H. C. Day, Vice President; H. C. Baker, Vice-President. First cement was shipped in 1910; capacity per day 700 barrels. Principal officers at present are: C. A. Day, President; H. C. Day, Vice President and General Manager; C. R. Hollingsworth, Secretary; F. N. Bletcher, Treasurer. One mill located at Bakers, Box Elder County, Utah (Mail Address, Brigham City). Present capacity per day 1,200 barrels. The raw materials used are marl and clay. The wet process of manufacture is employed. Have two 7½ by 100 foot and one 7½ by 125 foot kilns. Use pulverized coal as fuel.

OKLAHOMA PORTLAND CEMENT COMPANY, DENVER, COLORADO.

Organized originally in 1906 under the present name. Principal officers when organized were: Adam L. Beck, President; C. C. Bishop, Vice President; J. I. Wintersmith, Secretary-Treasurer. First cement was shipped in 1907; capacity per day 2,000 barrels. Reorganized in 1918. Principal officers at present are: Charles Boettcher, President and Treasurer; C. K. Boettcher, Vice President; R. J. Morse, Secretary. Two mills located at Ada, Oklahoma. Present capacity per day 6,000 barrels. The raw materials used are lime and shale. The wet and dry processes

of manufacture are employed. Have seven kilns, two $7\frac{1}{2}$ by 125 feet, two 9 by 125 feet and three 10 by 240 feet. Natural gas is used as fuel.

OLD MISSION PORTLAND CEMENT COMPANY, SAN FRANCISCO, CALIFORNIA.

Principal officers are: William F. Humphrey, President; J. A. McCarthy, Vice President, Manager and Sales Manager; G. D. Perry, Secretary. Mills located at San Juan, San Benito County, California. Capacity per day 2,000 barrels. Wet process of manufacture is employed. Have four $7\frac{1}{2}$ by 150 foot kilns. Oil is used as fuel for burning.

THE OLYMPIC PORTLAND CEMENT COMPANY, LTD., SEATTLE, WASHINGTON.

Organized in 1910 under the present name. Principal officers when organized were: Alexander B. Williamson, Chairman, Board of Directors; Thomas Rose, Secretary; Balfour, Guthrie & Company, Purchasing and Sales Agents and Managers. First cement was shipped in 1913; capacity per day 2,000 barrels. Principal officers at present are same as when organized. One mill located at Bellingham, Wash. Present capacity per day 2,000 barrels. The raw materials used are limestone and clay. The wet process of manufacture is employed. Have two 10 by 9 by 170 foot kilns. Oil is used as fuel.

OREGON PORTLAND CEMENT COMPANY, PORTLAND, OREGON.

Organized originally in 1915 under the name Portland Cement Company. Principal officers were: Andrew Smith, President; Aman Moore, Vice President and General Manager. First cement was shipped in 1916; capacity per day 1,150 barrels. Later on the name was changed to Oregon Portland Cement Company. Principal officers at present are: R. P. Butchart, President; L. C. Newlands, Vice President and General Manager; Carl W. Gath, Secretary-Treasurer. One mill located at Oswego, Oreg. Present capacity per day 1,150 barrels. The raw materials used are cement rock and lime rock. The wet process of manufacture is employed. Have one 10 by 9 by 210 foot kiln. Oil is used as fuel.

PACIFIC PORTLAND CEMENT COMPANY, CONSOLIDATED, SAN FRANCISCO, CALIFORNIA.

Organized originally in 1901 under the name Pacific Portland Cement Company. Principal officers were: George Stone, President; Nathan L. Bell, Secretary. First cement was shipped in 1902; capacity per day 450 barrels. Reorganized in 1905 under the name Pacific Portland Cement Company, Cons. Principal officers at present are: Robert B. Henderson, President; J. D. McKee, Vice President; H. T. Battelle, Secretary. One mill located at Cement, Calif. Present capacity per day 4,200 barrels. The raw materials used are rock and clay. The dry process of manufacture is employed. Have ten 80 foot kilns and one 100 foot kiln. Fuel oil is used.

PEERLESS PORTLAND CEMENT COMPANY, DETROIT, MICHIGAN.

Organized originally in 1897 under the name The Peerless Portland Cement Company. Principal officers were: A. W. Wright, President; S. O. Bush, Vice President; Wm. M. Hatch, Secretary-Treasurer. First cement was shipped in 1897; capacity per day 250 barrels. Reorganized in 1907 under the name Peerless Portland Cement Company. Principal officers at present are: Wm. M. Hatch, President and Manager; Chas. S. Bush, Vice President; John Gillespie, Secretary-Treasurer. One mill located at Union City, Michigan. Present capacity per day 2,000 barrels. The raw material used is marl. The wet process of manufacture is employed. Have nine $6\frac{1}{2}$ by 80 foot kilns. Coal is used as fuel.

PENINSULAR PORTLAND CEMENT COMPANY, CEMENT CITY, MICHIGAN.

Organized in 1899 under the present name. Principal officers were: Riley R. Reynolds, Sr., President; Cyrenius A. Newcomb, Vice President; W. F. Cowham, Secretary; N. S. Potter, Treasurer. First cement was shipped in 1901; capacity per day 750 barrels. Principal officers at present are: John L. Senior, President; P. L. Carter, Vice President; F. W. Boley, Secretary; H. J. Weeks, Treasurer. One mill located at Cement City, Michigan. Present capacity per day 3,000 barrels. The raw materials used are marl and clay, and limestone. The semi-wet process of manufacture is employed. Have three kilns. Coal is used as fuel.

PENN-ALLEN CEMENT COMPANY, ALLENTOWN, PENNSYLVANIA.

Organized originally in 1902 under the name Penn-Allen Portland Cement Company. Principal officers when organized were: Avon Barnes, President; W. R. Yeager, Treasurer; James K. Bowen, Secretary. First cement was shipped in 1903. Capacity per day 1,000 barrels. Reorganized in 1910 under the name Penn-Allen Cement Company. Principal officers at present are: W. E. Erdell, President; E. A. Wolfe, Vice President; H. E. Hess, Treasurer; T. O. Bretherton, Secretary. One mill located at Penn-Allen, Nazareth District. Present capacity per day 3,000 barrels. The raw materials used are cement rock and limestone. The dry process of manufacture is employed. Have six 7 by 80 foot kilns, one 8 by 80 foot kiln and one 8 by 125 foot kiln. Gas and coal used as fuel.

PENNSYLVANIA CEMENT COMPANY, NEW YORK CITY.

Organized in 1900 under the present name. Principal officers when organized were: W. N. Beach, President; A. H. Alker, Vice President; R. E. Bonner, Secretary-Treasurer. First cement was shipped in 1903; capacity per day 1,000 barrels. Principal officers at present are: W. N. Beach, President; J. W. Alker, Vice President; E. P. Alker, Treasurer; W. J. Canary, Secretary. Two mills located at Bath, Pennsylvania, and Portland Point, New York. Present capacity per day at Bath 5,000 barrels and at Portland Point 3,000 barrels. The raw material used is cement rock. The dry process of manufacture is employed. Have eleven 9 by 125 foot kilns. Coal is used as fuel.

PETOSKEY PORTLAND CEMENT COMPANY, PETOSKEY, MICHIGAN.

Organized in 1917 under the present name. Principal officers were: A. B. Klise, President; Homer Sly, Vice President; John L. A. Galster, Secretary-Treasurer. First cement was shipped in 1921; capacity per day 2,000 barrels. Principal officers at present are: J. B. John, President; Homer Sly, Vice President; Jos. A. Magnus, Vice President; John L. A. Galster, Secretary-Treasurer. One mill located at Petoskey, Michigan. Present capacity per day 2,000 barrels. The raw materials used are limestone and shale. The wet process of manufacture is employed. Have two 10 by 150 foot kilns. Coal is used as fuel.

PHOENIX PORTLAND CEMENT COMPANY, PHILADELPHIA.

Organized originally in 1899 under the name Phoenix Cement Company. Principal officers were: Francis D. H. Banks, President; Wm. B. Shaffer, Secretary; Frank C. H. Schweyer, Treasurer. First cement was shipped in 1900; capacity per day 1,000 barrels. In 1909 reorganized under the name Phoenix Portland Cement Company. Principal officers at present are: Lindley C. Morton, President; J. W. Walker, Vice President; E. P. Haubert, Secretary; A. W. Nash, Jr., Treasurer. Have two mills located at Nazareth, Pennsylvania and Birmingham, Alabama. Present capacity per day 7,500 barrels. The raw materials used at Birmingham are shale and limestone and at Nazareth cement rock. The dry process of manufacture is employed. There are four kilns at Nazareth, 9 by 100 feet, and three kilns at Birmingham, 10 by 150 feet. Pulverized coal is used as fuel.

PITTSBURGH PLATE GLASS COMPANY, ZANESVILLE, OHIO.

First cement shipped in 1924. Principal officers are: C. W. Brown, President; W. L. Clause, Chairman, Board; H. A. Galt, Vice President; H. S. Wherett, Vice President; C. L. Brown, Secretary; Edward Pitcairn, Treasurer; F. A. Jones, Manager. One mill located at Fultonham, Ohio. Present capacity per day 2,500 barrels. The raw materials used are limestone and shale. The wet process of manufacture is employed. Have two 10 by 165 foot kilns. Powdered coal is used as fuel.

PORTLAND CEMENT COMPANY OF UTAH, SALT LAKE CITY, UTAH.

Principal officers are: P. J. Moran, President; Ashby Snow, Vice President and Manager; Herbert A. Snow, Secretary-Treasurer and Sales Manager. Mill located at Salt Lake City. Present capacity per day 1,200 barrels. Dry process of manufacture is employed. Have two 8 by 125 foot kilns. Coal is used as fuel.

PYRAMID PORTLAND CEMENT COMPANY, DES MOINES, IOWA.

Organized in 1919 under the present name. Principal officers when organized were: John L. Blakely, President; E. Struckmann, Vice President and General Manager; W. A. Harper, Secretary; A. O. Hauge, Treasurer. First cement was shipped in 1923; capacity per day 3,000 barrels. Principal officers at present are: F. H. Mackaman, Chairman, Board; R. J. Hild, Secretary; A. O. Hauge, Treasurer. One mill located at Valley Junction, Iowa. Present capacity per day 3,000 barrels. The raw materials used are limestone and shale. The wet process of manufacture is employed. Have one 10 by 240 foot kiln. Bituminous coal is used as fuel.

RIVERSIDE PORTLAND CEMENT COMPANY, LOS ANGELES, CALIFORNIA.

Organized originally in 1906 under the name Southern California Cement Company. Principal officers when organized were: Wm. G. Henshaw, President; Tyler Henshaw, Vice President; W. W. Poole, Works Manager; John Treanor, Sales Manager. Capacity per day 600 barrels. In 1909 reorganized under the name Riverside Portland Cement Company. Principal officers at present are: Griffith Henshaw, Vice President; John Treanor, Vice President and General Manager; Wm. H. Metcalf, Secretary. One mill located at Oro Grande. Present capacity per day 5,000 barrels. The raw materials used are limestone and shale. The dry process of manufacture is employed. Have seven 8 by 125 foot kilns. Fuel oil is used.

SAN ANTONIO PORTLAND CEMENT COMPANY, SAN ANTONIO, TEXAS.

Organized originally in 1908 under the name Alamo Portland and Roman Cement Company. Principal officers when organized were: Geo. H. Kalteyer, President; B. J. Mauermann, Secretary-Treasurer. First cement was shipped in 1910; capacity per day 10 barrels. In the same year reorganized under the name San Antonio Portland Cement Company. Principal officers at present are: C. Baumberger, President; C. Baumberger, Jr., Vice President; Alb. Kronkosky, Secretary; Chas. Baldus, Treasurer. One mill located at Cementville, Texas. Present capacity per day 1,500 barrels. The raw materials used are argillaceous limestone and clay. The process used in manufacture is dry, changing to wet. Have two 8 by 125 foot kilns.

THE SANDUSKY CEMENT COMPANY, CLEVELAND, OHIO.

Organized originally in 1892 under the name The Sandusky Portland Cement Company. Principal officers when organized were: D. P. Eells, President; A. St. J. Newberry, Secretary-Treasurer; S. B. Newberry, Vice President and General Manager. First cement was shipped in 1893; capacity per day 100 barrels. In 1900

reorganized under the name The Sandusky Portland Cement Company of Ohio. In 1916 adopted the name The Sandusky Cement Company. Principal officers at present are: J. B. John, President and General Manager; C. F. Brush, Vice President; E. J. Maguire, Secretary-Treasurer. Have four mills located at Bay Bridge, Ohio, Toledo, Ohio, Dixon, Ill., and York, Pa. Present capacity per day 10,800 barrels. The raw materials used at the various mills are: Bay Bridge—marl, limestone and clay; Toledo—clay, limestone and shale; Dixon—shale and limestone; York—clay and limestone. The wet process of manufacture is used at Toledo, Bay Bridge, and York and the dry process is used at Dixon. Have seventeen 8 by 100 foot kilns and three 10 by 150 foot kilns. Coal is used as fuel.

SANTA CRUZ PORTLAND CEMENT COMPANY, SAN FRANCISCO, CALIFORNIA.

Organized in 1905 under the present name. Principal officers when organized were: W. C. Webb, President; W. S. Downing, Vice President; Edwin Schwab, Secretary; A. F. Morrison, Treasurer. First cement shipped in 1907; capacity per day 4,000 barrels. Principal officers at present are: Geo. T. Cameron, President; C. E. Green, Vice President; W. W. Crocker, Vice President; W. R. Berry, Secretary-Treasurer; Geo. R. Gay, General Manager. One mill located at Davenport, California. Present capacity 10,000 barrels. The raw materials used are lime rock and clay. The dry process of manufacture is employed. Have eighteen 7½ by 125 foot kilns and one 10 foot vertical. Oil is used as fuel.

SECURITY CEMENT & LIME COMPANY, HAGERSTOWN, MARYLAND.

Organized originally in 1907 under the name Maryland Portland Cement Company. Principal officers when organized were: Loring A. Cover, President; Wm. G. Nolting, Vice President; H. B. Warner, Secretary; Loring A. Cover, Treasurer. First cement shipped in 1908; capacity per day 750 barrels. Reorganized in 1909 under the name Security Cement & Lime Company. Principal officers at present are: Loring A. Cover, President; John J. Porter, First Vice President; J. A. Mason, Second Vice President; Alexander M. Tyree, Secretary-Treasurer. Two mills located at Security, Maryland and Berkeley, West Virginia. Present capacity per day 5,000 barrels. The raw materials used are limestone and shale. The dry process of manufacture is employed. Have five 10 by 8 by 125 foot kilns. Pulverized coal is used as fuel.

SIGNAL MOUNTAIN PORTLAND CEMENT COMPANY, CHATTANOOGA, TENNESSEE.

Organized in 1920 under the present name. Principal officers when organized were: C. H. Huston, Chairman, Board of Directors; R. C. Lubien, President; Geo. P. Dieckmann, Vice President; Ralph Law, Secretary; J. P. Hoskins, Treasurer. First cement was shipped in 1923. Principal officers at present are: W. A. Sadd, Chairman, Board of Directors; John L. Senior, President; C. S. Steward (Act.) Vice President; J. L. Caldwell, Vice President; J. P. Hoskins, Secretary-Treasurer. One mill located at Chattanooga, Tennessee. Present capacity per day 3,000 barrels. The raw materials used are limestone and clay. The process of manufacture used is semi-wet. Have two 11 by 175-foot kilns. Coal is used as fuel.

SOUTHERN STATES PORTLAND CEMENT COMPANY, ROCKMART, GEORGIA.

Organized in 1902. Principal officers when organized were: W. F. Cowham, President; J. W. Boardman, Sr., Treasurer; H. F. Van Deventer, Secretary. First cement was shipped in 1903; capacity per day 1,200 barrels. Principal officers at present are: T. J. Flournoy, President; M. P. Lane, Treasurer; B. Cowden, Secre-

tary. One mill located at Rockmart, Ga. Present capacity per day 1,500 barrels. The raw materials used are limestone and shale. The dry process of manufacture is employed. Have eight 6 by 60 foot kilns. Coal is used as fuel.

SOUTHWESTERN PORTLAND CEMENT COMPANY, LOS ANGELES, CALIFORNIA.

Organized in 1907 under the present name. Principal officers when organized were: C. Leonardt, President; Felix Martinez, Vice President; C. C. Merrill, Vice President; James G. McNary, Treasurer; O. J. Binford, Secretary. First cement was shipped in 1909; capacity per day 1,500 barrels. Principal officers at present are: C. Leonardt, President; C. C. Merrill, Vice President; James G. McNary, Treasurer; O. J. Binford, Secretary. One mill located at El Paso, Texas, and one at Victorville, California. Present capacity per day 9,000 barrels. The raw materials used are cement rock, limestone, and shale. The wet process of manufacture is employed at one plant and the dry process at the other. Have two 10 foot 6 inch by 9 foot by 200 foot kilns and two 9 by 200 foot, two 10 by 8 by 150 foot, and one 8 by 150 foot kiln. Oil is used as fuel at Victorville and coal at El Paso.

SUN PORTLAND CEMENT COMPANY, PORTLAND, OREGON.

Organized in 1922 under the present name. Principal officers were: H. A. Ross, President; G. Macdonald, Vice President; C. T. W. Hollister, Secretary. First cement was shipped in 1923; capacity per day 1,100 barrels. Principal officers at present are: H. A. Ross, President; G. Macdonald, Vice President; C. T. W. Hollister, Secretary. One mill located at Lime, Oregon. Present capacity per day 1,100 barrels. The raw materials used are lime rock and shale. The wet process of manufacture is employed. Have one 10 by 210 foot kiln. Fuel oil is used.

SUPERIOR PORTLAND CEMENT COMPANY, SEATTLE, WASHINGTON.

Organized in 1906 under the present name. Principal officers when organized were: John C. Eden, President; Francis B. Clarke, Vice President; R. V. Ankeny, Treasurer; W. W. Butler, Secretary. First cement was shipped in 1907; capacity per day 600 barrels. Principal officers at present are: John C. Eden, President; James R. Stirrat, Vice President; S. L. Barnes, Secretary; A. A. Sutherland, Treasurer. One mill located at Concrete, Wash. Present capacity per day 4,000 barrels. The raw materials used are limestone and clay. The wet process of manufacture is employed. Have two 9 by 8 by 193 foot and three 8 by 7 by 135 foot kilns. Pulverized coal is used as fuel.

TEXAS PORTLAND CEMENT COMPANY, DALLAS, TEXAS.

Organized originally in 1900 under the name Texas Portland Cement Company. Principal officers when organized were: Leon Blum, President; Jos. Levy, Vice President; E. R. Cheesborough, Secretary-Treasurer; Jas. T. Taylor, General Manager. First cement was shipped in 1900; capacity per day 500 barrels. Reorganized in 1901 under the name Texas Portland Cement & Lime Company; 1904, Iola Portland Cement Company of Texas; 1908, Texas Portland Cement Company. In 1914 adopted the name Texas Portland Cement Company. Principal officers at present are: F. R. Bissell, Chairman, Board; H. Struckmann, President; J. A. Wheeler, Vice President and Treasurer; Henry C. Coke, Secretary. Two mills located at Cement City, R. F. D. 6, Dallas, Texas, and Manchester, suburb of Houston, Texas. Present capacity per day 6,500 barrels. The raw materials used at Cement City are rock and shale and at Manchester shell and clay. The wet process of manufacture is employed. Have three 9 by 8 by 220 foot kilns at Cement City and three 9 by 8 by 220 foot kilns at Manchester. Fuel oil is used.

THREE FORKS PORTLAND CEMENT COMPANY, DENVER, COLORADO.

Organized in 1907 under the present name. Principal officers when organized were: James Pingree, President; F. T. McBride, Vice President; Charles Boettcher, Vice President; Joseph Scowcroft, Vice President; Hyrum Pingree, Secretary; James Pingree, Treasurer. First cement was shipped in 1907; capacity per day 1,500 barrels. Principal officers at present are: Charles Boettcher, President and Treasurer; C. K. Boettcher, Vice President; R. J. Morse, Secretary. Two mills at Trident, Montana and Hanover, Montana. Capacity per day 2,250 barrels at Trident and 1,000 barrels at Hanover at the present time. The raw materials used are high and low lime at Trident and lime and shale at Hanover. The dry process of manufacture is employed at Trident and the wet process at Hanover. Have three $9\frac{1}{2}$ by 150 foot kilns at Trident and one $9\frac{1}{2}$ by 8 by 200 foot kiln at Hanover. Coal is used as fuel.

TIDEWATER PORTLAND CEMENT COMPANY, BALTIMORE, MARYLAND.

Organized in 1909 under the present name. Principal officers when organized were: B. T. Scott, Founder; J. K. Tener, W. J. O'Brien, Jr., and J. A. McKellip. First cement shipped in 1911; capacity per day 4,000 barrels. Principal officers at present are: B. T. Scott, President; O. E. Foster, Vice President; W. A. Shaw, Vice-President; W. J. O'Brien, Jr., Vice President and Secretary. One mill located at Union Bridge, Maryland. Present capacity per day 5,000 barrels. The raw materials used are limestone and shale. The dry process of manufacture is employed. Have six $8\frac{1}{2}$ by 120 foot kilns. Pulverized coal is used as fuel.

TRINITY PORTLAND CEMENT COMPANY, DALLAS, TEXAS.

Organized originally in 1907 under the name Southwestern States Portland Cement Company. Principal officers when organized were: Wm. F. Cowham, President; A. C. Stich, Vice President; W. H. L. McCourtie, Secretary; N. S. Potter, Treasurer. First cement was shipped in 1909; capacity per day 2,500 barrels. Reorganized in 1915 under the name Trinity Portland Cement Company. Principal officers at present are: W. H. L. McCourtie, President; C. E. Ulrickson, Vice President and General Manager; F. G. Ray, Secretary; M. J. Scanlon, Treasurer. One mill located at Eagle Ford, Texas. Present capacity per day 4,500 barrels. The raw materials used are limestone and shale. The dry process of manufacture is employed. Have three 8 by 125 foot kilns and two 10 by 8 by 125 foot kilns. Fuel oil is used.

UNION PORTLAND CEMENT COMPANY, DENVER, COLORADO.

Organized in 1906 under the present name. Principal officers were: C. W. Nibley; President; Joseph Scowcroft, Vice President; M. S. Browning, Vice President, Reed Smoot, Vice President; James Pingree, Secretary-Treasurer. First cement was shipped in 1907; capacity per day 2,000 barrels. Principal officers at present are: Charles Boettcher, President and Treasurer; C. K. Boettcher, Vice President; R. J. Morse, Secretary. One mill located at Devils Slide, Utah. Present capacity per day 2,000 barrels. The raw materials used are high and low lime. The dry process of manufacture is employed. Have four 8 by 150 foot kilns. Coal is used as fuel.

THE UNITED STATES PORTLAND CEMENT COMPANY, DENVER, COLORADO.

Organized originally in 1906 under the present name. Principal officers when organized were: J. D. Blunt, President; G. D. Cummings, Vice President; Lee Champion, Treasurer; W. H. Kelso, Secretary. First cement was shipped in 1908; capacity per day 750 barrels. Reorganized in 1909. Principal officers at present are:

Charles Boettcher, President; R. J. Morse, Vice President; J. E. Zahn, Secretary-Treasurer. One mill is located at Concrete, Colorado. Present capacity per day 2,100 barrels. The raw materials used are lime and shale. The dry process of manufacture is employed. Have two 8 by 125 foot kilns and one 9 by 125 foot kiln. Coal is used as fuel.

UNIVERSAL PORTLAND CEMENT COMPANY, CHICAGO.

Organized originally in 1896 as the Cement Department of Illinois Steel Company, Chicago. Principal officer when organized, Edward M. Hagar, President. First cement shipped in 1896; capacity per day 500 barrels. Reorganized in 1906 under the present name. Principal officer at present is B. F. Affleck, President. Five mills, located as follows: three at Buffington, Indiana, near Chicago; one at Universal, Pennsylvania, near Pittsburgh; and one at Morgan Park, Duluth, Minnesota. Present capacity per day 46,000 barrels. The raw materials used are granulated blast furnace slag, limestone, and gypsum. The dry process of manufacture is employed. Have 65 kilns: at Buffington plant fourteen 7 by 80 foot kilns, twelve 7½ by 120 foot kilns, thirteen 10 by 140 foot kilns and one 10 by 200 foot kiln. At Pittsburgh plant twenty 7½ by 120 foot kilns and at the Duluth plant four 10 by 150 foot kilns and one 10 by 200 foot kiln. Pulverized coal used as fuel.

VIRGINIA PORTLAND CEMENT CORPORATION, NORFOLK, VIRGINIA.

Organized in 1924 under the present name. Principal officers are: F. R. Bissell, Chairman, Board; H. Struckmann, President and General Manager; H. C. Koch, Vice President; Baxter D. McClain, Secretary; H. H. Muehlke, Treasurer. One mill located at Norfolk, Virginia. The raw materials used are marl and clay. The wet process of manufacture is employed. Have three 9 by 8 by 220 foot kilns. Coal or oil is used as fuel.

VULCANITE PORTLAND CEMENT COMPANY, PHILADELPHIA.

Organized in 1894 under the present name. Principal officers when organized were: George W. Elkins, A. B. Bonneville and John B. Lober. First cement was shipped in 1895; capacity per day 200 barrels. Principal officers at present are: John B. Lober, President; W. D. Lober, Vice President; C. L. Filbert, Secretary-Treasurer. Two mills located at Vulcanite Station—C. R. R. of N. J., Warren County, New Jersey. Present capacity per day 6,000 barrels. The raw materials used are cement rock and limestone. The dry process of manufacture is employed. Have eight 125 foot kilns and six 60 foot kilns. Pulverized coal and gas used as fuel.

WABASH PORTLAND CEMENT COMPANY, DETROIT, MICHIGAN.

Organized in 1899 under the present name. Principal officers when organized were: A. L. Stephens, President; James H. McMillan, Vice President; Bethune Duffield, Secretary; Martin G. Borgman, Treasurer; Emil Stroh, General Manager. First cement was shipped in 1900; capacity per day 500 barrels. Principal officers at present are: Emil Stroh, President and Treasurer; J. T. McMillan, Vice President; H. F. Jennings, Secretary. Two mills located at Stroh, Indiana and Osborn, Ohio. Present capacity per day 500 barrels. The raw materials used are marl, limestone, and clay. The wet process of manufacture is employed. Have three 10 by 165 foot kilns and three 8½ by 185 foot kilns. Coal is used as fuel.

THE WELLSTON IRON FURNACE COMPANY, JACKSON, OHIO.

Incorporated in 1916 and acquired mill by purchase in 1918. The original name was The Superior Portland Cement Company. Principal officers at present are: S. E. Stephenson, President; Joseph McGhee, Secretary; S. A. Sternberger, Treasurer. Present capacity per day 2,000 barrels. One mill located at Superior, Lawrence County, Ohio. The dry process of manufacture is employed. Have four 7½ by 125 foot kilns. Coal is used as fuel.

WHITEHALL CEMENT MANUFACTURING COMPANY, PHILADELPHIA.

Principal officers are: W. H. Harding, President; W. O. Lentz, Vice President; P. D. Gaskill, Vice President and Treasurer; L. H. Baer, Secretary. Mill located at Cementon, Pa. Capacity per day 6,000 barrels. Dry process of manufacture is employed. Have five 8½ by 120 foot kilns and one 10 by 120 foot kiln. Coal is used as fuel.

WOLVERINE PORTLAND CEMENT COMPANY, COLDWATER, MICHIGAN.

Organized originally in 1898 under the name Michigan Portland Cement Company. Principal officers when organized were: L. M. Wing, President; Chas. Briggs, Vice President; E. R. Root, Secretary-Treasurer. First cement was shipped in 1898; capacity per day 2,500 barrels. Reorganized in 1902 under the present name. Principal officers at present are: C. C. Jones, President; A. E. Robinson, Vice President; P. H. Sweeney, Secretary-Treasurer. Two mills located at Coldwater, Michigan and Quincy, Michigan. Present capacity per day 2,800 barrels. The raw materials used are marl and clay. The wet process of manufacture is employed. Have three 8 by 187 foot kilns at Coldwater and seven 6 by 120 foot kilns at Quincy. Pulverized coal used as fuel.

WYANDOTTE PORTLAND CEMENT COMPANY, DETROIT, MICHIGAN.

Organized originally in 1903 under the name Michigan Alkali Company. Principal officers when organized were: Edward Ford, President; J. B. Ford, Vice President; E. L. Ford, Secretary-Treasurer. First cement shipped 1901; capacity per day 300 barrels. Adopted the name Wyandotte Portland Cement Company. Principal officers at present are: J. B. Ford, President; E. L. Ford, Vice President; John W. Boardman, Vice President; S. T. Crapo, Secretary-Treasurer. One mill located at Wyandotte, Michigan. Present capacity per day 1,000 barrels. The raw materials used are lime slurry and clay. The wet process of manufacture is employed. Have three 7 by 100 foot kilns. Coal is used as fuel.

APPENDIX D

AMERICAN SOCIETY FOR TESTING MATERIALS

1315 Spruce Street, Philadelphia, Pa.

STANDARD SPECIFICATIONS AND TESTS

FOR

PORTLAND CEMENT

Serial Designation: C 9 - 21

These specifications and tests are issued under the fixed designation C 9; the final number indicates the year of original adoption as standard, or in the case of revision, the year of last revision.

ADOPTED, 1904; REVISED, 1908, 1909, 1916, 1920 (EFFECTIVE JAN. 1, 1921)

These specifications were approved March 31, 1922,
as "American Standard" by the
American Engineering Standards Committee

SPECIFICATIONS

Definition

1. Portland cement is the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

I. CHEMICAL PROPERTIES

2. The following limits shall not be exceeded:

Chemical Limits

Loss on ignition, per cent.....	4.00
Insoluble residue, per cent.....	0.85
Sulfuric anhydride (SO ₃), per cent.....	2.00
Magnesia (MgO), per cent.....	5.00

II. PHYSICAL PROPERTIES

Specific Gravity

3. The specific gravity of cement shall be not less than 3.10 (3.07 for white portland cement). Should the test of cement as received fall below this requirement a second test may be made upon an ignited sample. The specific gravity test will not be made unless specifically ordered.

Fineness

4. The residue on a standard No. 200 sieve shall not exceed 22 per cent by weight.

Soundness

5. A pat of neat cement shall remain firm and hard, and show no signs of distortion, cracking, checking or disintegration in the steam test for soundness.

Time of Setting

6. The cement shall not develop initial set in less than 45 minutes when the Vicat needle is used or 60 minutes when the Gillmore needle is used. Final set shall be attained within 10 hours.

Tensile Strength

7. The average tensile strength in pounds per square inch of not less than three standard mortar briquettes (see Section 50) composed of one part cement and three parts standard sand, by weight, shall be equal to or higher than the following:

Age at Test, days	Storage of Briquettes	Tensile Strength, lb. per sq. in.
7	1 day in moist air, 6 days in water.....	200
28	1 day in moist air, 27 days in water.....	300

8. The average tensile strength of standard mortar at 28 days shall be higher than the strength at 7 days.

III. PACKAGES, MARKING, AND STORAGE**Packages and Marking**

9. The cement shall be delivered in suitable bags or barrels with the brand and name of the manufacturer plainly marked thereon, unless shipped in bulk. A bag shall contain 94 pounds net. A barrel shall contain 376 pounds net.

Storage

10. The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment, and in a suitable weather-tight building which will protect the cement from dampness.

IV. INSPECTION

11. Every facility shall be provided the purchaser for careful sampling and inspection at either the mill or at the site of the work, as may be specified by the purchaser. At least 10 days from the time of sampling shall be allowed for the completion of the 7-day test, and at least 31 days shall be allowed for the completion of the 28-day test. The cement shall be tested in accordance with the methods hereinafter prescribed. The 28-day test shall be waived only when specifically so ordered.

V. REJECTION

12. The cement may be rejected if it fails to meet any of the requirements of these specifications.

13. Cement shall not be rejected on account of failure to meet the fineness requirement if upon retest after drying at 100° C. for one hour it meets this requirement.

14. Cement failing to meet the test for soundness in steam may be accepted if it passes a retest using a new sample at any time within 28 days thereafter.

15. Packages varying more than 5 per cent from the specified weight may be rejected; and if the average weight of packages in any shipment, as shown by weighing 50 packages taken at random, is less than that specified, the entire shipment may be rejected.

TESTS

VI. SAMPLING

Number of Samples

16. Tests may be made on individual or composite samples as may be ordered. Each test sample should weigh at least 8 pounds.

17. (a) *Individual Sample*.—If sampled in cars one test sample shall be taken from each 50 barrels or fraction thereof. If sampled in bins one sample shall be taken from each 100 barrels.

(b) *Composite Sample*.—If sampled in cars one sample shall be taken from one sack in each 40 sacks (or 1 barrel in each 10 barrels), and combined to form one test sample. If sampled in bins or warehouses one test sample shall represent not more than 200 barrels.

Method of Sampling

18. Cement may be sampled at the mill by any of the following methods that may be practicable, as ordered:

(a) *From the Conveyor Delivering to the Bin*.—At least 8 pounds of cement shall be taken from approximately each 100 barrels passing over the conveyor.

(b) *From Filled Bins by Means of Proper Sampling Tubes*.—Tubes inserted vertically may be used for sampling cement to a maximum depth of 10 feet. Tubes inserted horizontally may be used where the construction of the bin permits. Samples shall be taken from points well distributed over the face of the bin.

(c) *From Filled Bins at Points of Discharge*.—Sufficient cement shall be drawn from the discharge openings to obtain samples representative of the cement contained in the bin, as determined by the appearance at the discharge openings of indicators placed on the surface of the cement directly above these openings before drawing of the cement is started.

Treatment of Sample

19. Samples preferably shall be shipped and stored in air-tight containers. Samples shall be passed through a sieve having 20 meshes per linear inch in order to thoroughly mix the sample, break up lumps, and remove foreign materials.

VII. CHEMICAL ANALYSIS

LOSS ON IGNITION

Method

20. One gram of cement shall be heated in a weighed covered platinum crucible, of 20 to 25-cc. capacity, as follows, using either method (a) or (b) as ordered:

(a) The crucible shall be placed in a hole in an asbestos board, clamped horizontally so that about three-fifths of the crucible projects below, and blasted at a full red heat

for 15 minutes with an inclined flame; the loss in weight shall be checked by a second blasting for 5 minutes. Care shall be taken to wipe off particles of asbestos that may adhere to the crucible when withdrawn from the hole in the board. Greater neatness and shortening of the time of heating are secured by making a hole to fit the crucible in a circular disk of sheet platinum and placing this disk over a somewhat larger hole in an asbestos board.

(b) The crucible shall be placed in a muffle at any temperature between 900 and 1000° C. for 15 minutes and the loss in weight shall be checked by a second heating for 5 minutes.

Permissible Variation

21. A permissible variation of .025 will be allowed, and all results in excess of the specified limit but within this permissible variation shall be reported as 4 per cent.

INSOLUBLE RESIDUE

Method

22. To a 1-g. sample of cement shall be added 10 cc. of water and 5 cc. of concentrated hydrochloric acid; the liquid shall be warmed until effervescence ceases. The solution shall be diluted to 50 cc. and digested on a steam bath or hot plate until it is evident that decomposition of the cement is complete. The residue shall be filtered, washed with cold water, and the filter paper and contents digested in about 30 cc. of a 5 per cent solution of sodium carbonate, the liquid being held at a temperature just short of boiling for 15 minutes. The remaining residue shall be filtered, washed with cold water, then with a few drops of hot hydrochloric acid, 1:9, and finally with hot water, and then ignited at a red heat and weighed as the insoluble residue.

Permissible Variation

23. A permissible variation of 0.15 will be allowed, and all results in excess of the specified limit but within this permissible variation shall be reported as 0.85 per cent.

SULFURIC ANHYDRIDE

Method

24. One gram of the cement shall be dissolved in 5 cc. of concentrated hydrochloric acid diluted with 5 cc. of water, with gentle warming; when solution is complete 40 cc. of water shall be added, the solution filtered, and the residue washed thoroughly with water. The solution shall be diluted to 250 cc., heated to boiling, and 10 cc. of a hot 10 per cent solution of barium chloride shall be added slowly, drop by drop, from a pipette and the boiling continued until the precipitate is well formed. The solution shall be digested on the steam bath until the precipitate has settled. The precipitate shall be filtered, washed, and the paper and contents placed in a weighed platinum crucible and the paper slowly charred and consumed without flaming. The barium sulfate shall then be ignited and weighed. The weight obtained multiplied by 34.3 gives the percentage of sulfuric anhydride. The acid filtrate obtained in the determination of the insoluble residue may be used for the estimation of sulfuric anhydride instead of using a separate sample.

Permissible Variation

25. A permissible variation of 0.10 will be allowed, and all results in excess of the specified limit but within this permissible variation shall be reported as 2.00 per cent.

MAGNESIA

Method

26. To 0.5 g. of the cement in an evaporating dish shall be added 10 cc. of water to prevent lumping and then 10 cc. of concentrated hydrochloric acid. The liquid shall be gently heated and agitated until attack is complete. The solution shall then be evaporated to complete dryness on a steam or water bath. To hasten dehydration the residue may be heated to 150 or even 200° C. for one-half to one hour. The residue shall be treated with 10 cc. of concentrated hydrochloric acid diluted with an equal amount of water. The dish shall be covered and the solution digested for ten minutes on a steam bath or water bath. The diluted solution shall be filtered and the separated silica washed thoroughly with water.¹ Five cubic centimeters of concentrated hydrochloric acid and sufficient bromine water to precipitate any manganese which may be present, shall be added to the filtrate (about 250 cc.). This shall be made alkaline with ammonium hydroxide, boiled until there is but a faint odor of ammonia, and the precipitated iron and aluminum hydroxides, after settling, shall be washed with hot water, once by decantation and slightly on the filter. Setting aside the filtrate, the precipitate shall be transferred by a jet of hot water to the precipitating vessel and dissolved in 10 cc. of hot hydrochloric acid. The paper shall be extracted with acid, the solution and washings being added to the main solution. The aluminum and iron shall then be reprecipitated at boiling heat by ammonium hydroxide and bromine water in a volume of about 100 cc., and the second precipitate shall be collected and washed on the filter used in the first instance if this is still intact. To the combined filtrates from the hydroxides of iron and aluminum, reduced in volume if need be, 1 cc. of ammonium hydroxide shall be added, the solution brought to boiling, 25 cc. of a saturated solution of boiling ammonium oxalate added, and the boiling continued until the precipitated calcium oxalate has assumed a well-defined granular form. The precipitate after one hour shall be filtered and washed, then with the filter shall be placed wet in a platinum crucible, and the paper burned off over a small flame of a Bunsen burner; after ignition it shall be redissolved in hydrochloric acid and the solution diluted to 100 cc. Ammonia shall be added in slight excess, and the liquid boiled. The lime shall then be reprecipitated by ammonium oxalate, allowed to stand until settled, filtered and washed. The combined filtrates from the calcium precipitates shall be acidified with hydrochloric acid, concentrated on the steam bath to about 150 cc., and made slightly alkaline with ammonium hydroxide, boiled and filtered (to remove a little aluminum and iron and perhaps calcium). When cool, 10 cc. of saturated solution of sodium-ammonium-hydrogen phosphate shall be added with constant stirring. When the crystallin ammonium-magnesium orthophosphate has formed, ammonia shall be added in moderate excess. The solution shall be set aside for several hours in a cool place, filtered and washed with water containing 2.5 per cent of NH_3 . The precipitate shall be dissolved in a small quantity of hot hydrochloric acid, the solution diluted to about 100 cc., 1 cc. of a saturated solution of sodium-ammonium-hydrogen phosphate added, and ammonia drop by drop, with constant stirring, until the precipitate is again formed as described and the ammonia is in moderate excess. The precipitate shall then be allowed to stand about two hours, filtered and washed as before. The paper and contents shall be placed in a weighed platinum crucible, the paper slowly charred, and the resulting carbon carefully burned off. The precipitate shall then be ignited to constant weight over a Meker burner, or a blast not strong enough to soften or melt the pyrophosphate. The weight of magnesium pyrophosphate obtained multiplied by 72.5 gives the percentage of magnesia. The precipitate so obtained always contains some calcium and usually small quantities of iron, aluminum, and manganese as phosphates.

¹Since this procedure does not involve the determination of silica, a second evaporation is unnecessary.

Permissible Variation

27. A permissible variation of 0.4 will be allowed, and all results in excess of the specified limit but within this permissible variation shall be reported as 5.00 per cent.

VIII. DETERMINATION OF SPECIFIC GRAVITY

Apparatus

28. The determination of specific gravity shall be made with a standardized Le Chatelier apparatus which conforms to the requirements illustrated in Fig. 1. This apparatus is standardized by the United States Bureau of Standards. Kerosene free from water, or benzine not lighter than 62° Baume, shall be used in making this determination.

Method

29. The flask shall be filled with either of these liquids to a point on the stem between zero and one cubic centimeter, and 64 g. of cement, of the same temperature as the liquid, shall be slowly introduced, taking care that the cement does not adhere to the inside of the flask above the liquid and to free the cement from air by rolling the flask in an inclined position. After all the cement is introduced, the level of the liquid will rise to some division of the graduated neck; the difference between readings is the volume displaced by 64 g. of the cement.

The specific gravity shall then be obtained from the formula:

$$\text{Specific gravity} = \frac{\text{Weight of cement (g.)}}{\text{Displaced volume (cc.)}}$$

30. The flask, during the operation, shall be kept immersed in water, in order to avoid variations in the temperature of the liquid in the flask, which shall not exceed 0.5° C. The results of repeated tests should agree within 0.01.

31. The determination of specific gravity shall be made on the cement as received; if it falls below 3.10, a second determination shall be made after igniting the sample as described in Section 20.

IX. DETERMINATION OF FINENESS

Apparatus

32. Wire cloth for standard sieves for cement shall be woven (not twilled) from brass, bronze, or other suitable wire, and mounted without distortion on frames not less than 1½ inches below the top of the frame. The sieve frames shall be circular, approximately 8 inches in diameter, and may be provided with a pan and cover.

33. A standard No. 200 sieve is one having nominally an 0.0029-inch opening and 200 wires per inch standardized by the United States Bureau of Standards, and conforming to the following requirements:

The No. 200 sieve should have 200 wires per inch, and the number of wires in any whole inch shall not be outside the limits of 192 to 208. No opening between adjacent parallel wires shall be more than 0.0050 inch in width. The diameter of the wire should be 0.0021 inch and the average diameter shall not be outside the limits 0.0019 to 0.0023 inch. The value of the sieve as determined by sieving tests made in conformity with the standard specifications for these tests on a standardized cement which

gives a residue of 25 to 20 per cent on the No. 200 sieve, or on other similarly graded material, shall not show a variation of more than 1.5 per cent above or below the standards maintained at the Bureau of Standards.

Method

34. The test shall be made with 50 g. of cement. The sieve shall be thoroughly clean and dry. The cement shall be placed on the No. 200 sieve, with pan and cover

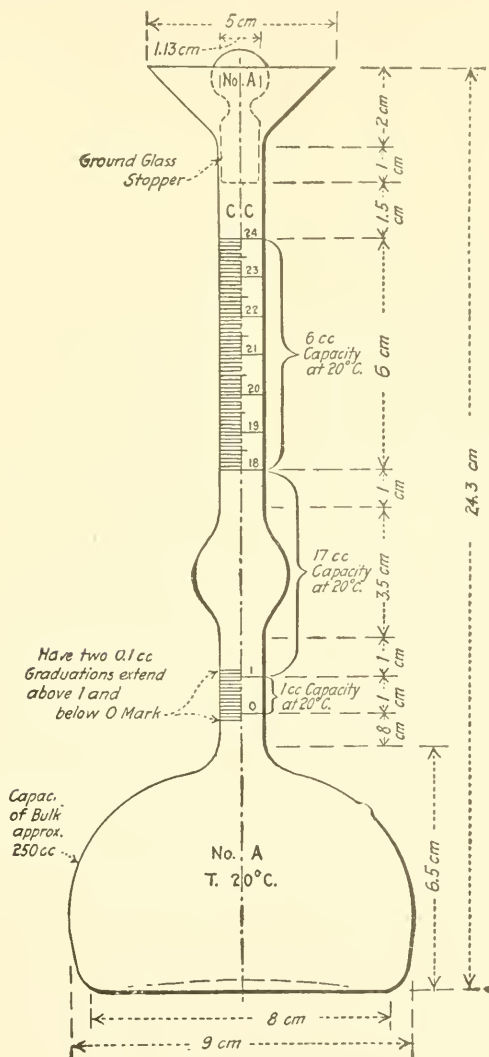


FIG. 1.—Le Chatelier Apparatus.

attached, if desired. The sieve shall be held in one hand in a slightly inclined position so that the sample will be well distributed over the sieve, at the same time gently strik-

ing the side about 150 times per minute against the palm of the other hand on the up stroke. This sieve shall be turned every 25 strokes about one-sixth of a revolution in the same direction. The operation shall continue until not more than 0.05 g. passes through in one minute of continuous sieving. The fineness shall be determined from the weight of the residue on the sieve expressed as a percentage of the weight of the original sample.

35. Mechanical sieving devices may be used, but the cement shall not be rejected if it meets the fineness requirement when tested by the hand method described in Section 34.

X. MIXING CEMENT PASTES AND MORTARS

Method

36. The quantity of dry material to be mixed at one time shall not exceed 1000 g. nor be less than 500 g. The proportions of cement, or cement and sand, shall be stated by weight in grams of the dry materials; the quantity of water shall be expressed in cubic centimeters (1 cc. of water = 1 g.). The dry materials shall be weighed, placed upon a non-absorbent surface, thoroughly mixed dry if sand is used, and a crater formed in the center, into which the proper percentage of clean water shall be poured; the material on the outer edge shall be turned into the crater by the aid of a trowel. After an interval of $\frac{1}{2}$ minute for the absorption of the water the operation shall be completed by continuous, vigorous mixing, squeezing and kneading with the hands for at least one minute.¹ During the operation of mixing, the hands should be protected by rubber gloves.

37. The temperature of the room and the mixing water shall be maintained as nearly as practicable at 21° C. (70° F.).

XI. NORMAL CONSISTENCY

Apparatus

38. The Vicat apparatus consists of a frame *A* (Fig. 2) bearing a movable rod *B*, weighing 300 g., one end *C* being 1 cm. in diameter for a distance of 6 cm., the other having a removable needle *D*, 1 mm. in diameter, 6 cm. long. The rod is reversible, and can be held in any desired position by a screw *E*, and has midway between the ends a mark *F* which moves under a scale (graduated to millimeters), attached to the frame *A*. The paste is held in a conical, hard-rubber ring *G*, 7 cm. in diameter at the base, 4 cm. high, resting on a glass plate *H* about 10 cm. square.

Method

39. In making the determination, 500 g. of cement, with a measured quantity of water, shall be kneaded into a paste, as described in Section 36, and quickly formed into a ball with the hands, completing the operation by tossing it six times from one hand to the other, maintained about 6 inches apart; the ball resting in the palm of one hand shall be pressed into the larger end of the rubber ring held in the other hand, completely filling the ring with paste; the excess at the larger end shall then be removed by a single movement of the palm of the hand; the ring shall then be placed on its larger end on a glass plate and the excess paste at the smaller end sliced off at the top of the ring by a

¹In order to secure uniformity in the results of tests for the time of setting and tensile strength, the manner of mixing above described should be carefully followed. At least one minute is necessary to obtain the desired plasticity which is not appreciably affected by continuing the mixing for several minutes. The exact time necessary is dependent upon the personal equation of the operator. The error in mixing should be on the side of over mixing.

single oblique stroke of a trowel held at a slight angle with the top of the ring. During these operations care shall be taken not to compress the paste. The paste confined in the ring, resting on the plate, shall be placed under the rod, the larger end of which shall be brought in contact with the surface of the paste; the scale shall be then read, and the rod quickly released. The paste shall be of normal consistency when the rod settles to a point 10 mm. below the original surface in $\frac{1}{2}$ minute after being released. The apparatus shall be free from all vibrations during the test. Trial pastes shall be made with

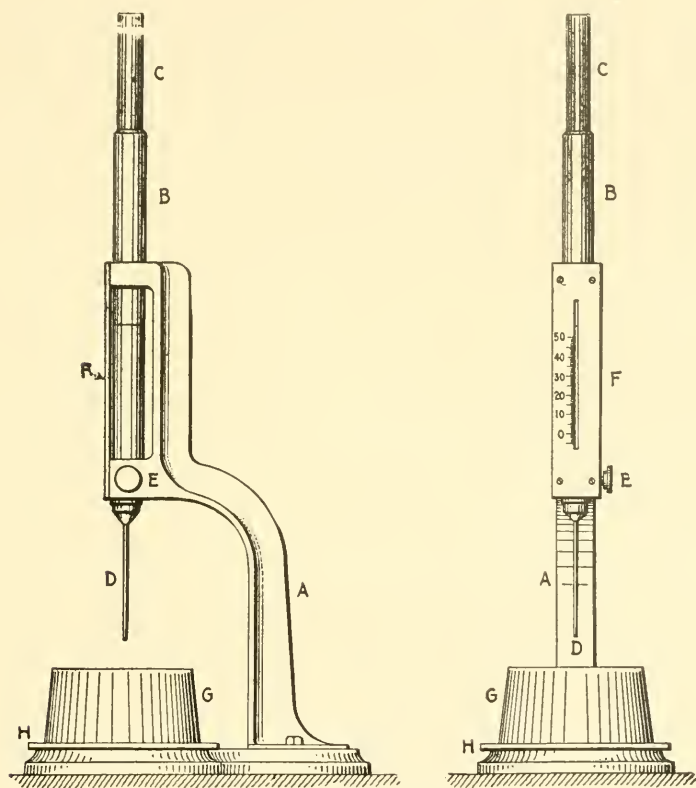


FIG. 2.—Vicat Apparatus.

varying percentages of water until the normal consistency is obtained. The amount of water required shall be expressed in percentage by weight of the dry cement.

40. The consistency of standard mortar shall depend on the amount of water required to produce a paste of normal consistency from the same sample of cement. Having determined the normal consistency of the sample, the consistency of standard mortar made from the same sample shall be as indicated in Table I, the values being in percentage of the combined dry weights of the cement and standard sand.

XII. DETERMINATION OF SOUNDNESS¹

Apparatus

41. A steam apparatus, which can be maintained at a temperature between 98 and 100° C., or one similar to that shown in Fig. 3, is recommended. The capacity of this apparatus may be increased by using a rack for holding the pats in a vertical or inclined position.

Method

42. A pat from cement paste of normal consistency about 3 inches in diameter, $\frac{1}{2}$ inch thick at the center, and tapering to a thin edge, shall be made on clean glass plates about 4 inches square, and stored in moist air for 24 hours. In molding the pat, the cement paste shall first be flattened on the glass and the pat then formed by drawing the trowel from the outer edge toward the center.

43. The pat shall then be placed in an atmosphere of steam at a temperature between 98 and 100° C. upon a suitable support 1 inch above boiling water for 5 hours.

44. Should the pat leave the plate, distortion may be detected best with a straight edge applied to the surface which was in contact with the plate.

¹Unsoundness is usually manifested by change in volume which causes distortion, cracking, checking or disintegration.

Pats improperly made or exposed to drying may develop what are known as shrinkage cracks within the first 24 hours and are not an indication of unsoundness. These conditions are illustrated in Fig. 4.

The failure of the pats to remain on the glass or the cracking of the glass to which the pats are attached does not necessarily indicate unsoundness.

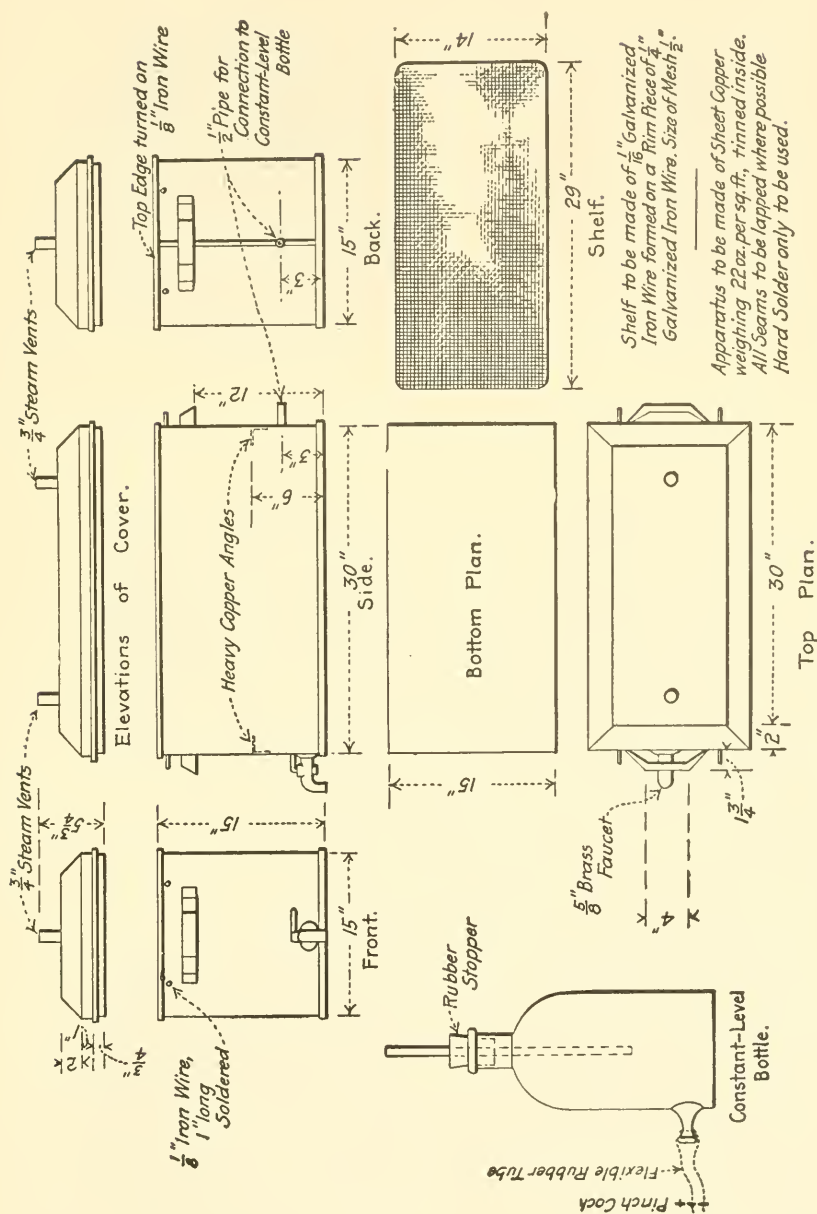


FIG. 3.—Apparatus for Making Soundness Test of Cement.

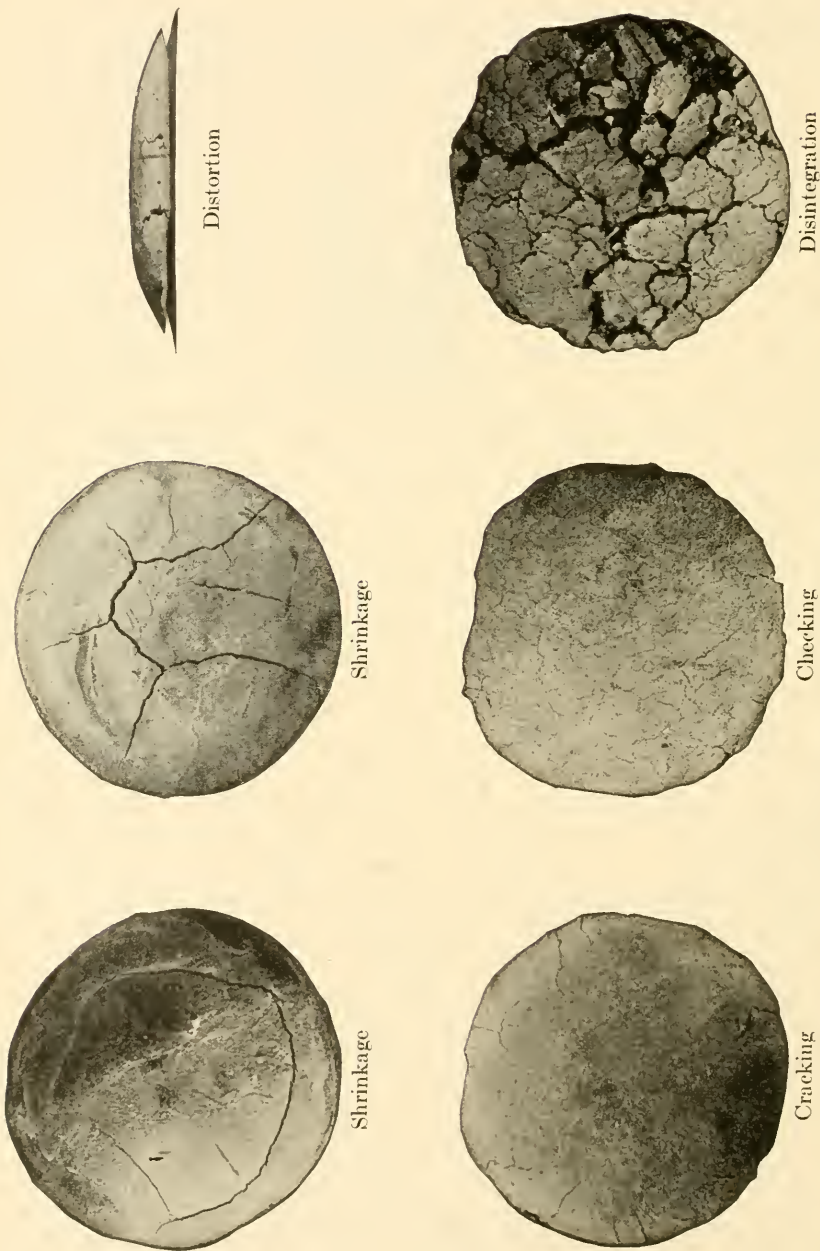


FIG. 4.—Typical Failures in Soundness Test.

XIII. DETERMINATION OF TIME OF SETTING

45. The following are alternate methods, either of which may be used as ordered:—

Vicat Apparatus

46. The time of setting shall be determined with the Vicat apparatus described in Section 38. (See Fig. 2.)

TABLE I—PERCENTAGE OF WATER FOR STANDARD MORTARS

Percentage of Water for Neat Cement Paste of Normal Consistency	Percentage of Water for One Cement Three Standard Ottawa Sand	Percentage of Water for Neat Cement Paste of Normal Consistency	Percentage of Water for One Cement, Three Standard Ottawa Sand
15	9.0	23	10.3
16	9.2	24	10.5
17	9.3	25	10.7
18	9.5	26	10.8
19	9.7	27	11.0
20	9.8	28	11.2
21	10.0	29	11.3
22	10.2	30	11.5

Vicat Method

47. A paste of normal consistency shall be molded in the hard-rubber ring *G* as described in Section 39, and placed under the rod *B*, the smaller end of which shall then be carefully brought in contact with the surface of the paste, and the rod quickly released. The initial set shall be said to have occurred when the needle ceases to pass a point 5 mm. above the glass plate in $\frac{1}{2}$ minute after being released; and the final set, when the needle does not sink visibly into the paste. The test pieces shall be kept in moist air during the test. This may be accomplished by placing them on a rack over water contained in a pan and covered by a damp cloth, kept from contact with them by means of a wire screen; or they may be stored in a moist closet. Care shall be taken to keep the needle clean, as the collection of cement on the sides of the needle retards the penetration, while cement on the point may increase the penetration. The time of setting is affected not only by the percentage and temperature of the water used and the amount of kneading the paste receives, but by the temperature and humidity of the air, and its determination is therefore only approximate.

Gillmore Needles

48. The time of setting shall be determined by the Gillmore needles. The Gillmore needles should preferably be mounted as shown in Fig. 5 (*b*).

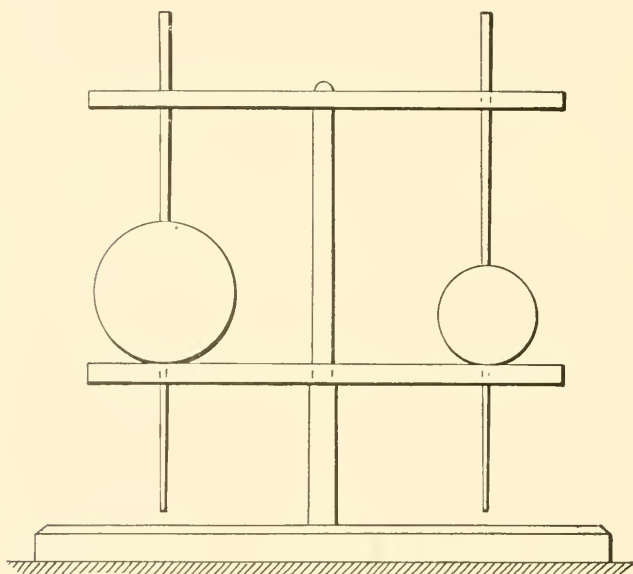
Gillmore Method

49. The time of setting shall be determined as follows: A pat of neat cement paste about 3 inches in diameter and $\frac{1}{2}$ inch in thickness with a flat top (Fig. 5 (*a*)), mixed to a normal consistency, shall be kept in moist air at a temperature maintained as nearly as practicable at 21° C. (70° F.). The cement shall be considered to have acquired its initial set when the pat will bear, without appreciable indentation, the Gillmore needle $1\frac{1}{12}$ inch in diameter, loaded to weigh $\frac{3}{4}$ pound. The final set has been acquired when the pat will bear without appreciable indentation, the Gillmore needle $1\frac{1}{24}$ inch in

diameter, loaded to weigh 1 pound. In making the test, the needles shall be held in a vertical position and applied lightly to the surface of the pat.



(a) Pat with Top Surface Flattened for Determining Time of Setting by Gillmore Method



(b) Gillmore Needles

FIG. 5.

XIV. TENSION TESTS

Form of Test Piece

50. The form of test piece shown in Fig. 6 shall be used. The molds shall be made of non-corroding metal and have sufficient material in the sides to prevent spreading during molding. Gang molds when used shall be of the type shown in Fig. 7. Molds shall be wiped with an oily cloth before using.

Standard Sand

51. The sand to be used shall be natural sand from Ottawa, Ill., screened to pass a No. 20 sieve and retained on a No. 30 sieve. This sand may be obtained from the Ottawa Silica Company, at a cost of three cents per pound, f. o. b. cars, Ottawa, Ill.

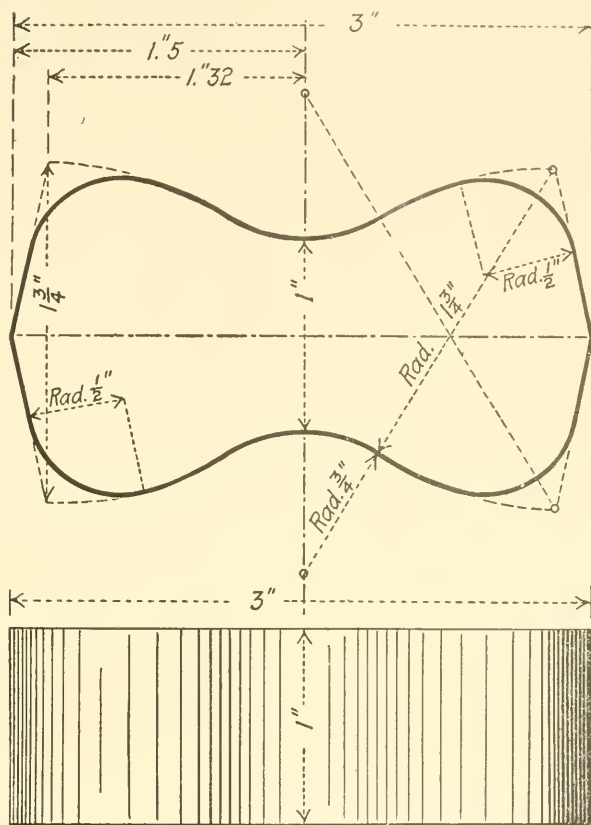


FIG. 6—Details for Briquette.

52. This sand, having passed the No. 20 sieve, shall be considered standard when not more than 5 g. passes the No. 30 sieve after one minute continuous sieving of a 500-g. sample.

53. The sieves shall conform to the following specifications:

The No. 20 sieve shall have between 19.5 and 20.5 wires per whole inch of the warp wires and between 19 and 21 wires per whole inch of the shoot wires. The diameter of the wire should be 0.0165 inch and the average diameter shall not be outside the limits of 0.0160 and 0.0170 inch.

The No. 30 sieve shall have between 29.5 and 30.5 wires per whole inch of the warp wires and between 28.5 and 31.5 wires per whole inch of the shoot wires. The diameter of the wire should be 0.0110 inch and the average diameter shall not be outside the limits 0.0105 to 0.0115 inch.

Molding

54. Immediately after mixing, the standard mortar shall be placed in the molds, pressed in firmly with the thumbs and smoothed off with a trowel without ramming. Additional mortar shall be heaped above the mold and smoothed off with a trowel; the

trowel shall be drawn over the mold in such a manner as to exert a moderate pressure on the material. The mold shall then be turned over and the operation of heaping, thumbing and smoothing off repeated.

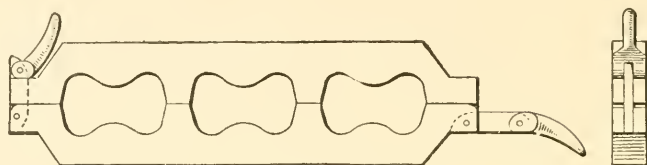


FIG. 7.—Gang Mold.

Testing

55. Tests shall be made with any standard machine. The briquettes shall be tested as soon as they are removed from the water. The bearing surfaces of the clips and briquettes shall be free from grains of sand or dirt. The briquettes shall be carefully centered and the load applied continuously at the rate of 600 pounds per minute.

56. Testing machines should be frequently calibrated in order to determine their accuracy.

Faulty Briquettes

57. Briquettes that are manifestly faulty, or that give strengths differing more than 15 per cent from the average value of all test pieces made from the same sample and broken at the same period, shall not be considered in determining the tensile strength.

XV. STORAGE OF TEST PIECES

Apparatus

58. The moist closet may consist of a soapstone, slate or concrete box, or a wooden box lined with metal. If a wooden box is used, the interior should be covered with felt or broad wicking kept wet. The bottom of the moist closet should be covered with water. The interior of the closet should be provided with non-absorbent shelves on which to place the test pieces, the shelves being so arranged that they may be withdrawn readily.

Methods

59. Unless otherwise specified, all test pieces, immediately after molding, shall be placed in the moist closet for from 20 to 24 hours.

60. The briquettes shall be kept in molds on glass plates in the moist closet for at least 20 hours. After from 20 to 24 hours in moist air the briquettes shall be immersed in clean water in storage tanks of non-corroding material.

61. The air and water shall be maintained as nearly as practicable at a temperature of 21 degrees C. (70 degrees F.).

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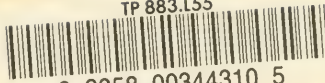
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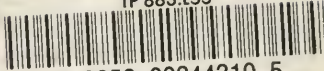
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